

Compressed Air

Magazine



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DECEMBER 1958

NEW YORK • LONDON

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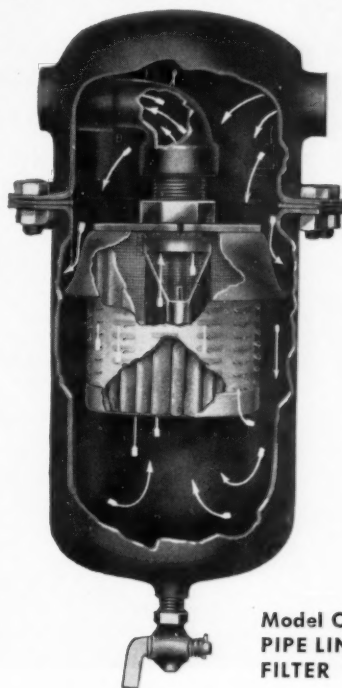
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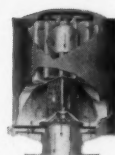
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Write for Bulletin 200 which contains complete engineering data and illustrated material on Staynew Pipe Line Filters. Dollinger Corporation, Dept. 7, Centre Park, Rochester 3, N. Y.



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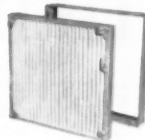
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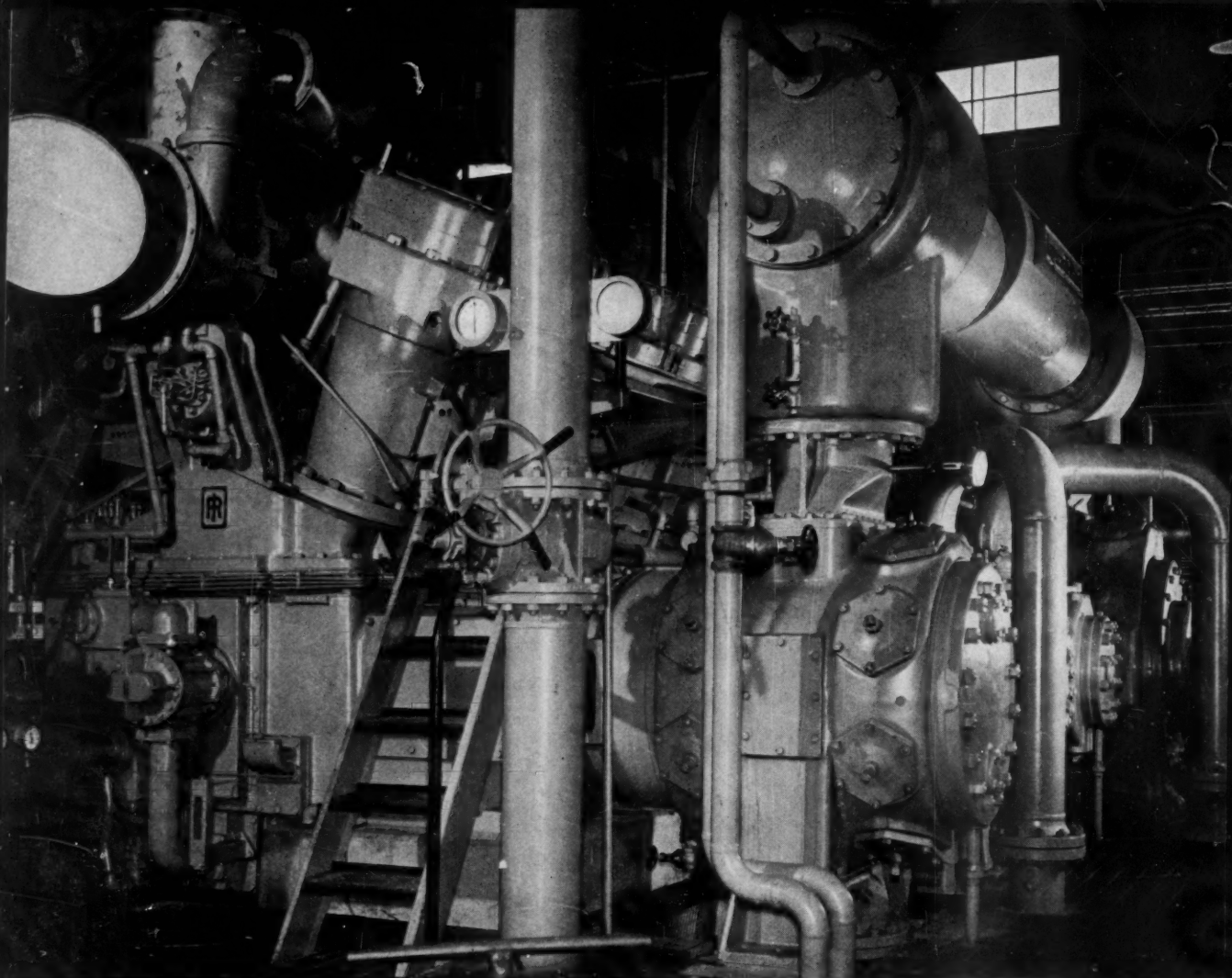
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New Birks Building, Montreal, Quebec



PHOTO, H. D. KYNOR, JR.

ON THE COVER

COVERED bridges have a fascination for many people—an interest that is heightened by seeing the structures in what is assumed to be their natural snow-covered settings. Actually, the structures were enclosed to protect their trusses and decking from exposure to sun and rain as well as snow. Some 1100 to 1200 of the spans are still in existence, it is said, and, strangely enough, an occasional one is still erected, although most of the recently built ones have been replacements of similar old historic crossings. With the picture of the quaint, nostalgic Vermont bridge on our cover, we send to our readers best wishes for the holiday season and coming New Year.

Compressed Air Magazine

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VOLUME 63 NUMBER 12

December 1958

FEATURE ARTICLES

Page 10 Two New Passenger Liners Join Grace Line—G. R. Smith

Grace Line's new "Santa Rosa" and "Santa Paula" are the first United States passenger liners to be delivered since the "United States" in 1952. They are also the first ships to be built under the nation's \$2.3 billion fleet replacement program. The "Santa Rosa" is described, and the part played by compressed air equipment and pumps in her workings is detailed.

16 On The Beam—C. H. Vivian

When gas is required to meet peak loads in Gainesville, Ga., a button actuating a radio control circuit is pushed. Miles away, a gas-engine-driven compressor in an unattended station roars into life and automatically comes on the line to boost pressure in the natural gas pipeline leading into the community. Its story and the one behind it are related.

21 Royal Gorge—Carey Holbrook

One of the West's innumerable river-worn canyons has a little longer history than most, is crossed by what is said to be the world's highest suspension bridge and has associated with it, a 45-degree incline railway.

24 Snow—S. M. Parkhill

The holiday season is associated with snow in most parts of the Northern hemisphere. Some of the science and industry of winter's mantle is related.

26 Something About Aspirin

Man's oldest "wonder drug" is continually finding new uses in medical practice.

30 \$20,000 Annual Savings

Pneumatic handling and airtight inert-gas-filled bins team to cut costs.

30 Moles Will Honor Armstrong, Bonny

The nineteenth annual honorary awards will be presented.

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G. W. Morrison, *Publisher*

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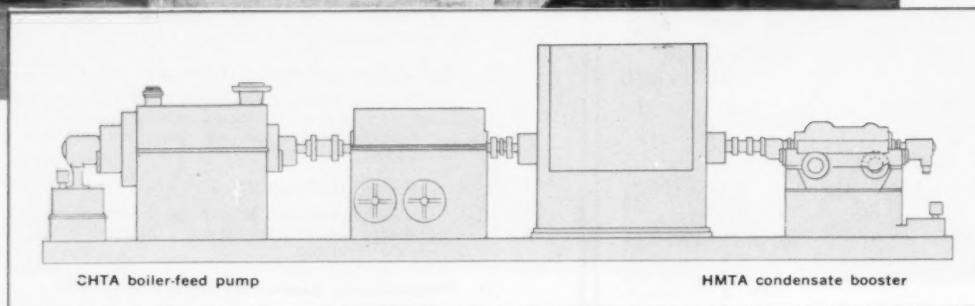
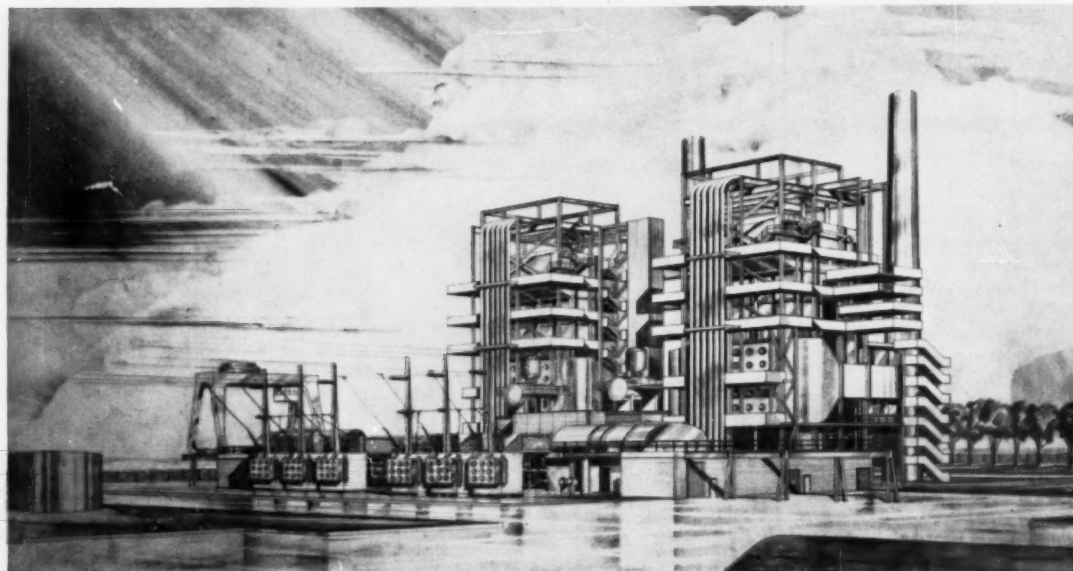
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For Southern California Edison Company's
new Huntington Beach Steam Station...



Ingersoll-Rand pumps will handle all boiler-feed water

WHEN completed, Southern California Edison Company's new Huntington Beach Station will have a name plate capacity of 820 MW of power ... with four cross-compound turbines and oil-and-gas fired boilers. For the first two units now under construction, Southern California Edison (and Bechtel Corp., engineer and constructor) has purchased 10 Ingersoll-Rand pumps to handle all boiler-feed water.

One of the arrangements of boiler-feed pump and condensate-booster pump is shown above. The feed pump at left is an I-R double-case pump rated

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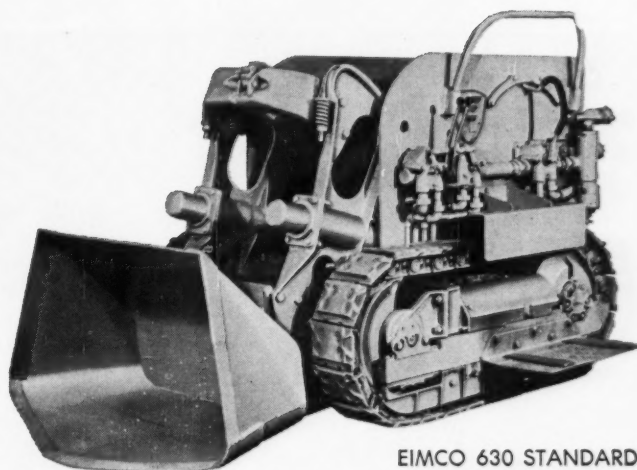
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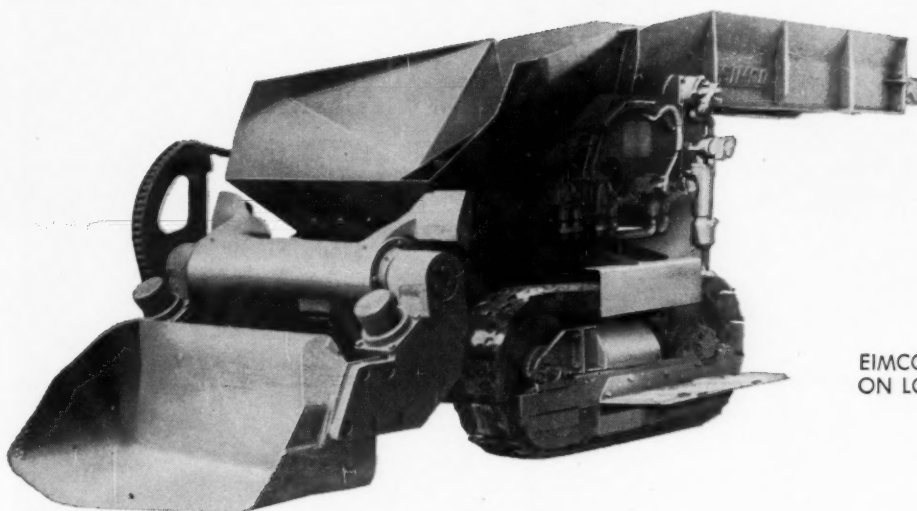


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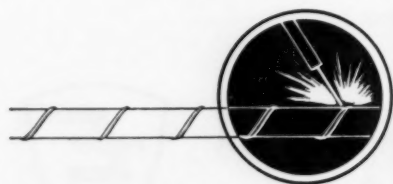
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CONQUEST OF SPACE

Underground!

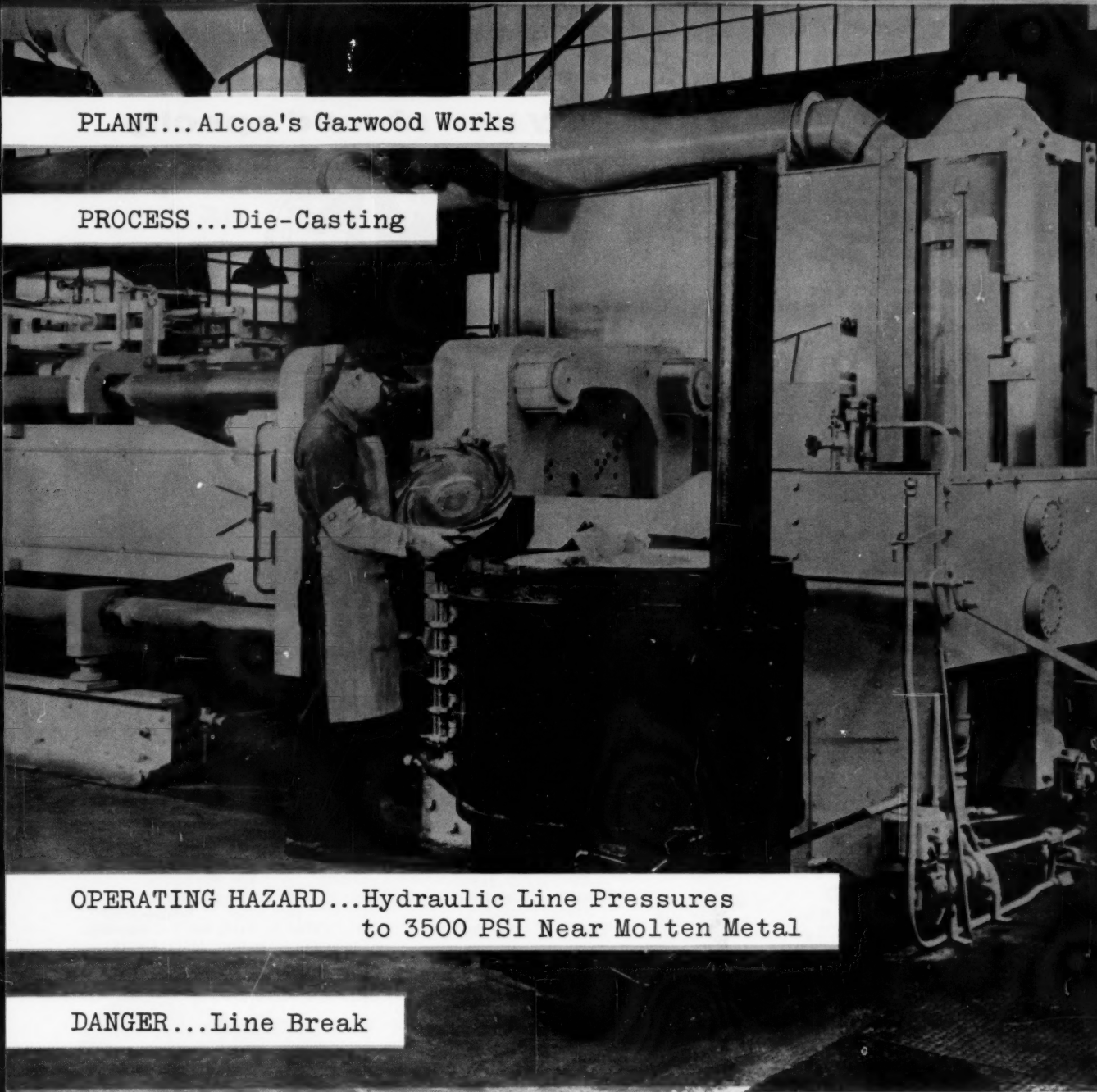
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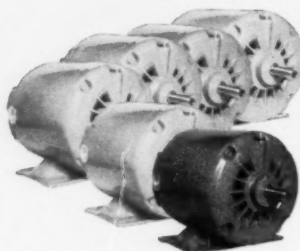
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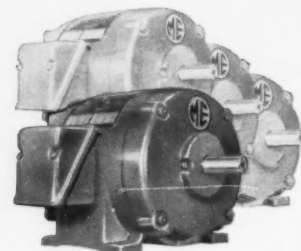
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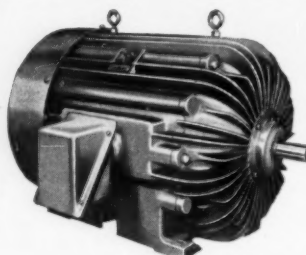
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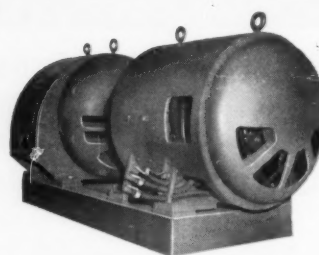
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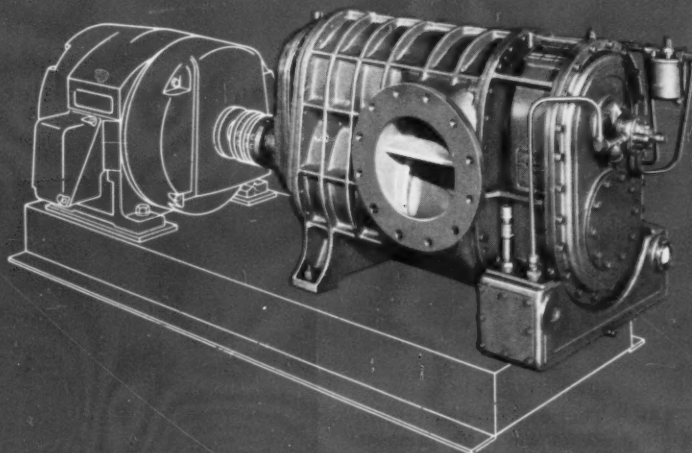
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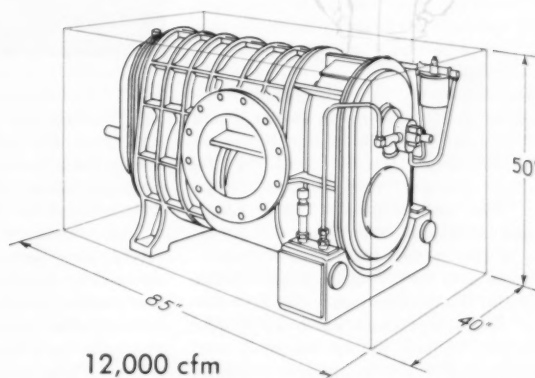
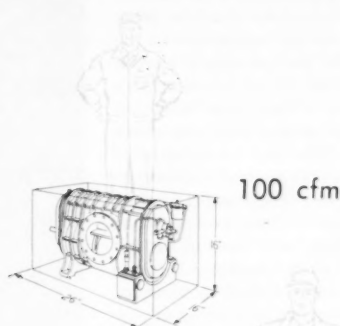
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TWO NEW PASSENGER JOIN GRACE LINE'S

Luxurious \$25-Million Vessels Bolster U. S. Maritime Strength

G. R. Smith

EACH Thursday morning, appearing out of the day's particular density of sea fog or haze, a sleek white liner moves into the busy waters of New York Harbor and heads for North River. About the time the great city is caught in the confusion of its workbound rush, the passenger liner is edging toward Pier 57 off Manhattan's lower west side. Tugs ease her into berth, she is tied up and gangplanks are run into place. The pier becomes alive with the liner's 300 tanned passengers leaving the ship for customs processing. Truck and winch activity are heard as the cargo loading and unloading get underway. The work continues through the night into the next day, until about 2 p.m. Friday when a fresh group of passengers starts coming aboard. Later all cargo hatches are secured, gangplanks and mooring lines taken in, and at 4 p.m., the liner backs away from the pier and points her bow southward toward the Caribbean.

One week the ship following this schedule bears the name *Santa Rosa*, and the next week the liner is her sister ship, the *Santa Paula*. Both fly the familiar diamond flag of Grace Line Inc. The two ships are Grace Line's newest additions and form the proud core of the company's 33-vessel fleet.

These are very special ships. Aside from the *Santa Rosa* being the first new U. S. passenger liner since 1952 (the year the United States Lines' *United States* sailed on her maiden voyage), the two *Santa*'s are among the first to be built under a \$2-3 billion fleet-replacement program being carried out mutually by the maritime industry and the

U. S. Government. Uncle Sam, by contributing part of the cost of ships like these \$25 million *Santa*'s, and by giving their operators certain other concessions, aims to keep the country's fleet healthy for defense reasons.

The vessels are very special in themselves, also, because of their completely up-to-date construction and the luxurious manner in which they are equipped to look after their 300 passengers. All passengers are booked first class in these ships. They have a greater space-per-passenger ratio than any others afloat. Like all Grace Line vessels, both passenger liners and freighters, they are built mainly to serve the Americas. These

two new *Santa*'s were designed for 12-day Caribbean cruises; and one of them leaves New York each Friday the year round, while the other is midpoint through an itinerary that includes La Guaira and Caracas, Venezuela; Curaçao and Aruba, Netherlands West Indies; Kingston, Jamaica; Nassau, Bahamas; and Port Everglades in the Miami-Fort Lauderdale locale.

An interesting feature about the *Santa Rosa* and the *Santa Paula* is that they are replacing ships by the same names. Their namesakes were delivered to Grace Line in 1932 and were the subject of an article in COMPRESSED AIR MAGAZINE in August of that year. Grace Line



R LINERS 'SANTA' FLEET



"SANTA ROSA" AT SEA

Flooded in Caribbean sunlight, Grace Line's new "Santa Rosa" continues on her tropical itinerary. The 583-foot-long luxury ship, and her sister vessel, "Santa Paula," spend 12 days carrying passengers on pleasure and business trips from New York to the Caribbean and South America. The liners, which also carry express cargo, cost \$25 million each and are the proud core of Grace Line's 33-vessel fleet—all "Santa's."

as the liner *United States* and the super-carriers, *USS Forrestal* and *USS Ranger*. Naval architects for the new *Rosa* and *Paula* were Gibbs & Cox Inc., of New York, the same firm, incidentally, that designed the 1932 ships. The *Santa Rosa*, which will be described in this article, was delivered to Grace Line on June 12, 1958. Her keel was laid January 15, 1957, and she was launched August 28, 1957. The *Santa Paula* is the newer ship, having started her maiden voyage October 17, 1958. Her keel laying date was April 9, 1957, and launching was on January 9, 1958.

Over-all length of the *Santa Rosa* is 583 feet 7 inches, and she has an estimated displacement of 19,364 tons. Her hull is full-bodied in beam and has graceful lines accented by a single elliptical stack she carries raked slightly aft. Above the hull, the ship's profile reveals a rounded forward house with a prominent radar mast rising from it. The superstructure is stepped aft and painted white. The hull is a very light gray, and the stack is ringed in wide bands of the company's black, white and green. A 6-inch white parabolic stripe separates the gray of the hull from the dark green visible above the water line.

Perhaps the most unique features of the *Santa Rosa* are her swimming pool, and her use of new antiroll fin stabilizers that reduce roll up to 90 percent. The pool is the largest outdoor type afloat and instead of being tile, is of Monel-clad steel for easier maintenance. The 14-foot-long antiroll fins are located

amidships in underwater recesses, both port and starboard, and are extended or retracted by engine room personnel on orders from the bridge. Their adjustment in operation is made on a console panel in the pilot house. Generally speaking, the Sperry Gyrofans work like this: a gyroscope-accelerometer senses the start of a roll, the roll velocity is determined, and a computer figures the lift required to neutralize the action. Signals are sent to hydraulic servos to obtain the correct fin angle. Deflection of the fin shafts halts the process when the roll has been damped. Each fin can produce a lifting force of about 70 tons to combat the roll tendency. The fins are useful in contributing to passenger comfort; they also reduce ship damage in rough water, stop cargo shifting and allow speed to be maintained in bad weather.

The *Santa Rosa* is a twin-screw, single-rudder ship having eight decks. All staterooms are outside and have private baths. Eleven main transverse bulkheads provide twelve watertight compartments designed so that the ship remains stable even if two of these areas are damaged and filled with water.

The forward house top, which is the top of the bridge, serves as a sun deck for the ship's officers. The compass platform, portable searchlights and the loop of the radio direction finder are here. Aft of this is the house top of the La Playa or sports deck. The stack, the shape of which was adapted after extensive wind tunnel tests, emerges from this location. The interior of the stack contains three vertically stepped sections ahead of the flue. Two of them house fan machinery and the other contains emergency generator and battery equipment. Soot extractors have been installed to prevent soot particles from falling onto passengers, the foreign matter being removed from combustion gases by a centrifugal cone and vane assembly.

The bridge contains the navigational and steering equipment: radar, loran (long range navigation instruments), gyrocompass, automatic course recorder and steering controls, engine order telegraphs and a public address system. Radio and radio-telephone, depth measuring equipment, smoke detection apparatus and the controls for the Gyrofans are here also. Aft of the bridge is a chart room for the navigator.

The La Playa Deck, aft of the bridge, is the site of the swimming pool, its long dimension running athwartship. Surrounding the pool are sunning and shade areas, and forward on the same deck is a bar. Below the La Playa Deck is a sun deck made up of ship's officer rooms, deluxe passenger suites and staterooms. A children's playroom is here also, as well as the ship's ten aluminum lifeboats, five each, port and starboard.

The next level is the Promenade Deck

ships bore these names even prior to 1932. An early *Santa Rosa*, of 1886 vintage, utilized both steam and sail propulsion, while the current *Santa Paula* is the third such Grace Line vessel. The old (1932) *Rosa* and *Paula* were sent to dry dock when the new ones were delivered. Two other sister ships built in 1932, the *Santa Elena* and *Santa Lucia*, were lost during World War II.

The new ships are completely identical except for a few months age and decorative differences of their interiors. Both were built by the venerable Newport News Shipbuilding & Dry Dock Company that has 69 years of shipbuilding experience, with such efforts to its credit

which serves as the public area for the ship. The Caribbean Lounge occupies the forward section and contains a library, the ship's altar, writing desks, card tables, etc. Aft of the lounge is a foyer, and then the ship's dining room with 84 tables, enough to seat all passengers. On this deck also are the main galley and Club Tropicana, site of the more formal evening activities.

Below the Promenade Deck is "A" Deck, longest on the ship. Anchor machinery is found forward and kingposts to aid cargo handling. An enclosure, 321 feet long, accommodates passengers, nearly the entire length being taken up by staterooms outside. The interior section, lying along the ship's centerline, is for ship's personnel and for offices such as those of the chief purser and chief steward.

"B" Deck has a windlass machinery room forward, crew facilities, two large hatches, crew and passenger accommodations, and air conditioning machinery. On this deck are medical facilities and several shops. "C" Deck contains crew accommodations, and cargo storage. "D" and "E" house refrigerated cargo, deep tanks for fuel oil and ballast, and maintenance shops. The hold has compartments for refrigerated and dry cargo and

tanks for fresh water, fuel oil and ballast. The ship's exceptionally clean engine and boiler rooms occupy two compartments amidships from "D" Deck to the hold.

The ship is driven by two 4-bladed screws of manganese bronze that produce a service speed of 20 knots. The driver consists of two cross-compound steam turbines that develop 20,000 shp working at cruising-speed revolutions. Roughly speaking, this is the same power needed to pull a 400-car freight train. Each of the two General Electric propulsion units consists of two turbines, one high pressure and one low pressure. The two work through double-helical, double-reduction articulated gears, also made by GE. The high-pressure turbines pass the steam through nine stages and low-pressure units utilize eight. These units are built so that both the low- and high-pressure types produce the same amount of power. At the maximum continuous rating of 22,000 shp, the high-pressure turbines rotate at 6670 rpm and the low-pressure units at 4200 rpm. Gears reduce these speeds to the propeller shaft speed of 124 rpm.

The turbines are located in the upper level of the engine room, where also are found the three 1200-kw turbo-

generators, one straddling the ship's centerline and one each, port and starboard. These generators produce 450-v, 60-cycle, 3-phase alternating current. Their turbines turn at 10,000 rpm that is reduced through single reduction gears to the 1200 rpm required by the generators. Although there are three of these units, two will supply the electrical demands of the vessel.

Also in the engine room's upper level are two 60,000-gallon-per-day low-pressure, submerged tube, double-effect water-distilling plants that meet the liner's fresh water demands. Each of these can supply 100 gallons per day per person in excess of the ship's operational needs. In this area too are the electrical distribution switchboard and three lube-oil tanks—one of 3500-gallon and two of 1800-gallon capacity.

The engine room's lower level houses two main condensers and the three turbogenerator condensers, attendant pumps, lubrication oil coolers and their pumps, the main engine reduction gears with lube-oil sumps of 1700-gallon capacity, bilge and fuel oil manifolds, and pumps for handling sewage and fresh water.

Refrigeration and air conditioning equipment are contained in the upper level of the boiler room. In the lower level are the boilers and two Ingersoll-Rand 4-stage horizontal CNTAM boiler feeder pumps that service them. These are located starboard and are powered with 364-hp steam turbine drives at 5100 rpm. If necessary, only one of these feeder pumps can handle all three boilers. A control board here allows adjustment for the most efficient combustion and regulates the feed into the boilers so that it equals the steam flowing out. Miscellaneous pumps handle fire pumping needs, chilled and hot water, air conditioning condenser requirements and sewage. Two Ingersoll-Rand Type 40 air compressors—2-stage, air-cooled, reciprocating units—provide air for the general service needs of the ship.

Air conditioning aboard the *Santa Rosa* is very complete and serves all public areas, passenger cabins and crew quarters. The system works through a cycle of steam preheat, chilled-water cooling and hot water reheat. Centrifugal fans located in special fan rooms force the air throughout the ship, and other fans withdraw air from the conditioned area. This air is either returned for reuse or exhausted overboard, according to the reaction of dampers that respond to outside air temperatures. Finned coils located in the main air ducts are utilized for heating or cooling the air, according to the outside air temperature. Two chillers in the boiler room supply the cold water and these units are served by Carrier Corporation 300-ton centrifugal compressors handling Freon-11.

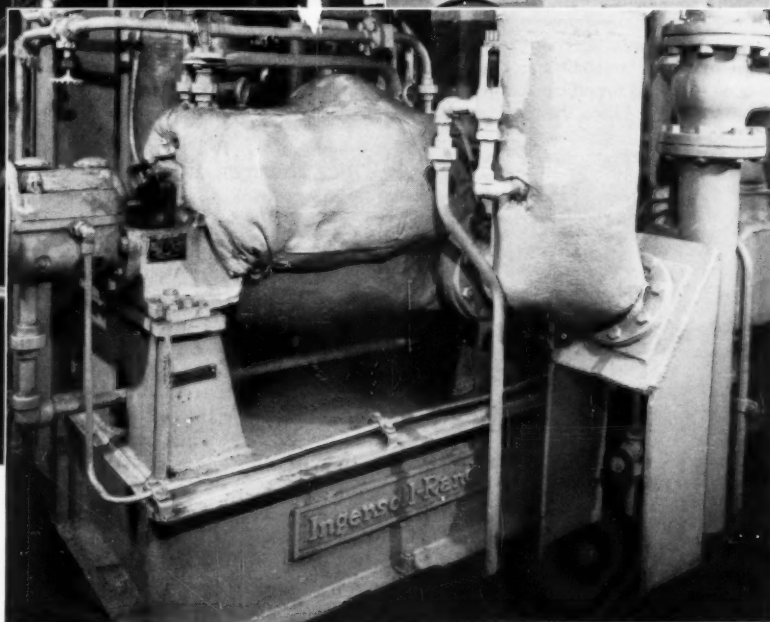
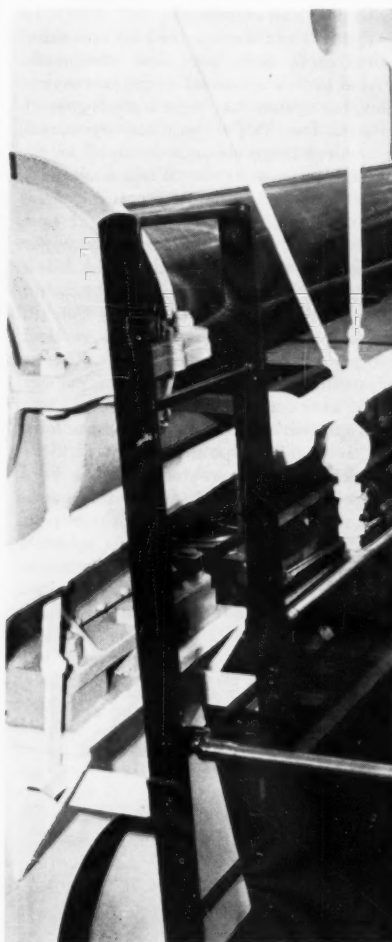
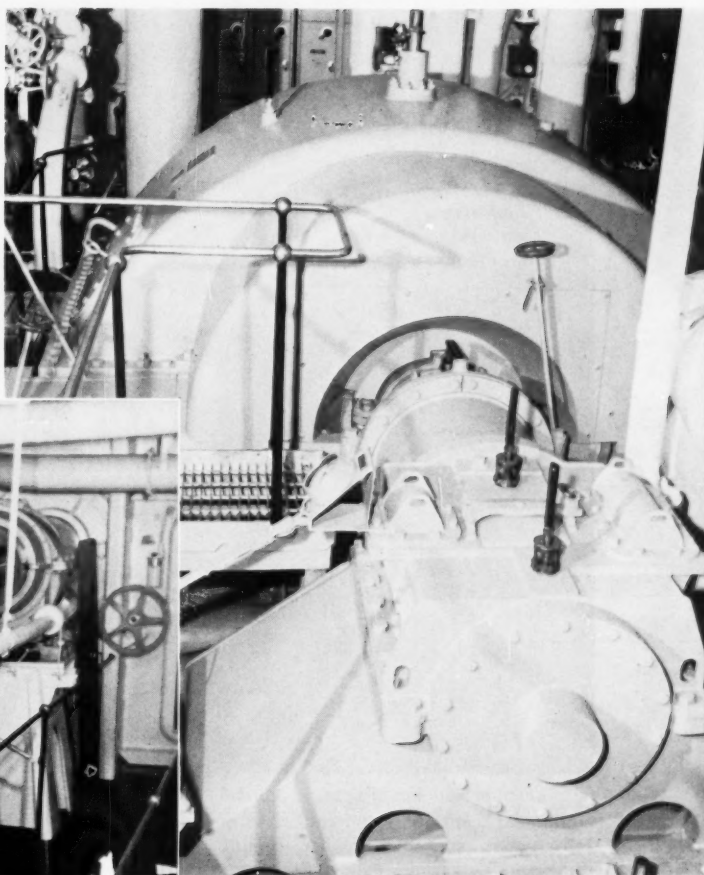
FLOATING DINING ROOM

This dining room aboard the "Santa Rosa" is large enough to accommodate all 300 first-class passengers and typifies the luxurious furnishings present throughout the ship. All staterooms are outside, and specially designed furniture and fabrics are utilized. The gay interiors are done in the bright blues, greens, yellows, reds and oranges, so evident in the tropics. Works of art—sculpture, mosaics, ceramics and watercolors to name a few—are included in the furnishings. The curtains in the dining room are of handwoven cloth. The mezzanine visible at the top of the photograph is for the ship's orchestra.



POWER FOR 20-KNOT SPEED

Here are three important components of the power plant system on the "Santa Rosa" supplying 22,000 shp to propel the liner at a service speed of 20 knots. The "Santa Paula's" is identical. Below, at right, is one of two Ingersoll-Rand CNTAM boiler feed pumps that operate at 5100 rpm, driven by 364-hp steam turbines. Swaddled in asbestos insulation, these pumps develop 1835 feet of head and supply water to the vessel's three boilers. Steam from the boilers operates two large main propulsion units, one of which is shown at right, with its gear housing in the foreground. The main engines, working through double-reduction gears drive two propeller shafts. One of these is shown immediately below.

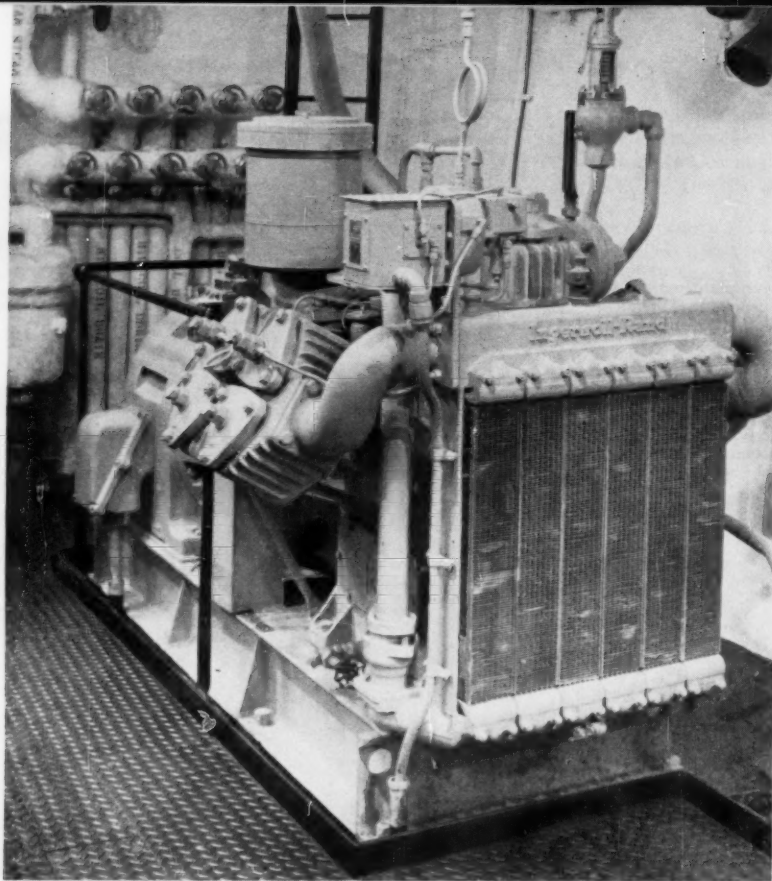


A pneumatic system controls the dampers and regulates the steam or water that goes to the heaters and coolers in this system. A pneumatic signal, that varies in proportion to the outside air temperature, goes to all damper and converter controls and thermostats. Ceiling-type diffusers distribute the conditioned air to the ship space.

Refrigeration is supplied for the *Santa Rosa* in three levels of the No. 3 Hold and two lower sections of No. 4 Hold.

(There are six hold compartments.) All, except for one level, can maintain temperatures as low as 25°F for storage of fruits and vegetables. This other level, designed for carrying frozen foods, can maintain a minus 10°F temperature.

Four reciprocating compressors handling Freon-12 provide the primary refrigerant for a total 277-ton capacity. Some 81,384 usable cubic feet of volume are contained in these hold levels. The ship's stores, using the same type of



GENERAL SERVICE AIR COMPRESSOR

The varied requirements of the "Santa Rosa" for compressed air are met with two Ingersoll-Rand Type 40 air compressors, such as the one illustrated, installed on the lower starboard side of the engine room. These are 2-stage, air-cooled, reciprocating machines. The other Type 40 is in an identical location portside, as part of the port-starboard balancing of all equipment in the ship's engine and boiler rooms. Receivers are positioned above the compressors.

es makes his job easier. These holds are loaded or unloaded through deck hatches, but each has one sideport at both port and starboard.

Holds 3 and 4 are served by two sideports each, both port and starboard. These utilize a special cargo conveyor-elevator system having a high degree of automation. Triple-chain conveyors and a vertical cargo elevator serve all levels of each of these areas. When a sideport door is opened, a 12-foot portable conveyor is cantilevered out from it and aligned with the long fixed conveyor affixed to the deck of the hold level. This long transporter moves the cargo to a smaller conveyor that has the job of depositing the load onto a vertical cargo elevator. An operator, working at a pushbutton console, selects the correct level and sends the load there. Then still another conveyor picks up the load at the delivery point, and a fork-lift truck moves the material to its final shipboard location. Limit switches control the flow of cargo pallets to prevent jam up, and as quickly as one pallet is removed, a signal is given for another to be placed in the now empty position.

equipment, contain 14,280 cubic feet of refrigerated space. Smaller cooling units supply various galleys and bars.

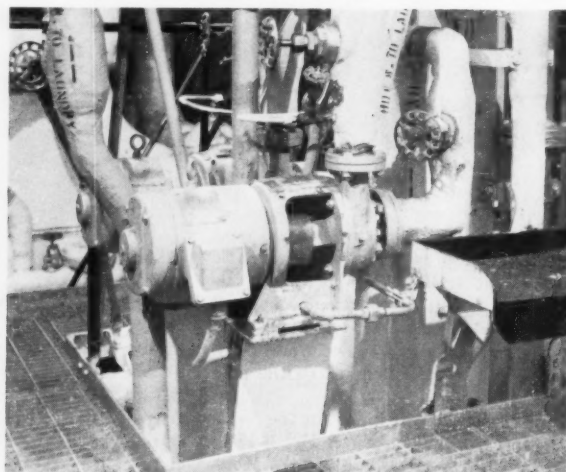
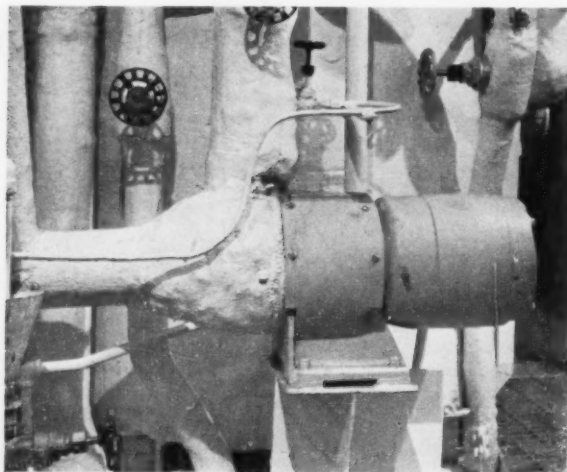
Although primarily a passenger vessel, the ship obviously carries a sizable amount of cargo, and she has the most advanced methods for efficient and quick cargo handling. Two systems are in

operation, one in use for holds 1, 2, 5 and 6, and another for 3 and 4. The former have a kingpost and boom gear setup in which an operator controls lifts, winches and hoists by a console panel. From his special platform, the operator has exceptional vision and control, and a safety system of limit switch-

COLD WATER, HOT WATER

These Ingersoll-Rand pumps perform valuable services aboard the "Santa Rosa" for both passenger and crew, and are among dozens of several types on the vessel. The unit at the left is an Ingersoll-Rand 1½ RV Motorpump that circulates ice-cold drinking water, a welcome commodity in the warm climates where the ship cruises. The pair of

pumps at the right are also Ingersoll Rand 1½ RV Motor-pumps. These hot water circulating units are part of the ship's complete air conditioning system that operates on a cycle of steam preheat, chilled-water cooling and hot water reheat. All public spaces as well as the living quarters are completely air conditioned.



Removal of cargo is the reverse of this operation.

The interiors of the ships are definitely modern in design and light in atmosphere. Because the vessels spend much of their time in the Caribbean and South America, the gay colors and distinctive art forms of these areas have been reflected. Blues, greens, yellows, reds and oranges comprise the interior color schemes, and the works of 26 artists are represented throughout the lounges, bars, staterooms and other interior areas. Mosaics, sculpture, murals, ceramics, metalwork, watercolors and ornamental fabrics are present. Furniture is fine mahogany and oak, and was designed especially for the ships, as were the furniture fabrics. Several materials, not usually associated with ship interiors, were adapted because of their lightweight, their ease of maintenance, their durability and resistance to fire. A rubber-based composition material, Neotex, covers the Promenade and Weather Decks. Micarta plastic is used for bulkhead surfaces of passageways, in staterooms, foyers, and even for beds and furniture. Other materials include Marinite, aluminum and Alumilite, Monel, Formica and laminated glass.

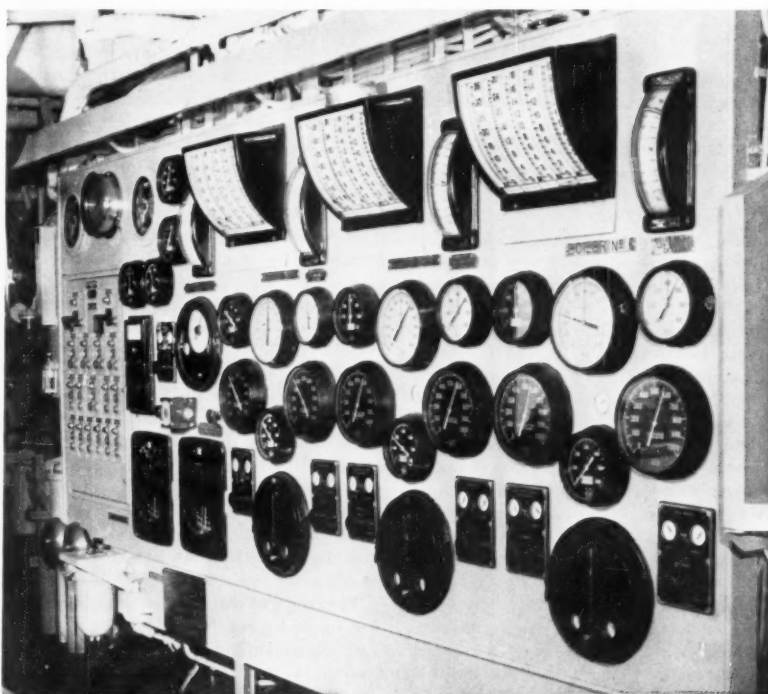
Grace Line Inc., is a wholly-owned subsidiary of the varied firm of W. R. Grace & Company. The company's founder, William Russell Grace, was born in Ireland and traveled to Peru in 1850 where he earned a partnership in a ship chandlery firm that soon bore his name. He moved to New York in the mid 1860's (later he was twice mayor of New York) where his company began chartering sailing vessels for trading purposes. He persuaded a shipbuilder to construct full-bodied ships with more cargo capacity than the famous and fleet clippers; these cargo craft were called *Down Easters* and are deeply embedded in the lore of the firm's early history. The ships normally sailed to South America and around the Horn to the U. S. Pacific Coast. Later a Grace ship was the first commercial vessel to enter the Panama Canal. The firm continued to grow, playing a large part in the country's industrial revolution, and during World War I the entire fleet went into the service of the U. S. government.

After that war, Grace Line inaugurated the first direct passenger service between New York, Peru and Chile. In the 1920's and '30's more ships were built—each bearing the *Santa* name that all Grace ships now carry. Grace vessels went into the military service again when World War II broke out, and during the conflict, five *Santa*'s were lost to enemy action. After the War, the Line returned to civilian service and in 1947 nine new cargo-passenger ships were built and the old *Santa Rosa* and *Santa Paula* became luxury liners again.



VITAL CONTROL AREAS

These illustrations show important control areas aboard the "Santa Rosa." The picture above depicts the modern bridge. Starting at the door and moving to the right, the equipment includes: photo-radar screen, automatic pilot, manual steering wheel, gyro-compass, engine room telegraph, and Gyrofin control panel. At left foreground is an automatic fire detection unit that constantly samples air and gives an alarm if smoke is detected. Orders given from the bridge eventually are evident in the many gauges and dials of the boiler room control panel (below). Steam-pressure and water-control readings appear there.





ON THE B

Radio Signals Control Georgia Comp

C. H. Vivian

WHEN a switch is thrown in the office of the Georgia Gas Company in Gainesville, Ga., an invisible hand instantly reaches out 16 miles to activate an unattended compressor station and increase the capacity of the pipeline supplying natural gas to the city. The "hand" consists of ultra-high-frequency radio waves that are beamed at the speed of light.

An article in our July 1958 issue told how a human hand that closes an electrical circuit in the Hooper Station of Northern Natural Gas Company near Omaha, Neb., puts a control board in command of a compressor and operates it automatically. In similar manner, a panel takes over at Georgia Gas Company, but without anyone going near it.

Once the station board is in charge, its instruments put the compressor in operation in orderly steps and watch over it while it is running. If trouble develops, the board indicates it immediately and, if it becomes serious, the unit is shut down before it can harm itself. Meanwhile, the microwave radio system keeps the Gainesville office informed by reporting back essential operating data, which are displayed on a board there.

The remotely controlled station, one of the first of its kind, is located about midway of a 31-mile pipeline that transmits the gas to Gainesville from Bogart, Ga., where it taps the Transcontinental Pipe Line that runs from the Southwest to New York City. The station is on a lightly traveled road, inside a wire-fence enclosure having gates that are normally locked. No one lives nearby. No one is in attendance, not even a ground maintenance man. The station

will be visited periodically to determine that all facilities are in proper working order. The present plan is to check it once a month during warm weather and once a week during the season when its operation may be required at any time.

The gas leaves the delivery station near Bogart at a pressure of 550 psig, and this normally suffices to push enough of it through the 4-inch line to supply the needs of the Gainesville area. Only on the coldest days of winter is the line capacity likely to be insufficient. When this happens, the switch is thrown in Gainesville to put the booster station in action. For the present, the station will probably operate only a few days of the year and for only a few hours of each of those days. As the service area grows and gas consumption increases, it will come into greater use, but in the foreseeable future it is not expected that it will run more than a fraction of the time. It is obvious, then, that it is economically desirable to have it unattended and to operate it from the company's headquarters.

Georgia Gas Company was organized in 1930. It is a division of United Cities Gas Company with headquarters in Chicago, Ill., and which has fourteen other operating divisions—four in southeastern Illinois, eight in Tennessee and one each in North Carolina and South Carolina. The Georgia unit is the largest in point of revenue earned. It serves slightly more than 3000 customers and receipts last year were \$463,597.

The first gas distributed at Gainesville was made by combining butane and air, and this continued until June 1952, when the tie-in was made with Transcontinental. It was foreseen then that a 4-inch

line would meet the requirements for only about 5 years. Serious consideration was given at that time to increasing the size to provide more capacity, but studies indicated that the greater investment that this would entail would not be justified by the expected revenues during the first 5 years of service. With limited funds with which to work, it was decided instead that it would be better to use the available funds for constructing major additions to the Gainesville distribution system, thereby enlarging the service area and increasing revenue.

The 5-year estimate proved to be correct, and in the summer of 1956 the management had to face the necessity of increasing the capacity for the 1957-58 heating season, assuming that normal winter temperatures would be experienced. "Our original thinking," says P. A. Ray, vice president and chief engineer of the company, "had been to provide additional capacity by 'looping' the existing pipeline (installing a parallel second line for a part of the route). However, our investigations in 1956 disclosed that to increase the capacity as desired would require looping approximately two-thirds of the total 31 miles. At prevailing construction costs, we found that we could install compression for about 70 percent of the cost of such looping. Long-range estimates also indicated that looping of even the full length of the line would not provide for ultimate capacity requirements and that compression would still eventually be needed."

Further study indicated that a radio-controlled "satellite" station located at about midpoint of the line would best

BEAM

pressor Station

serve the desired purpose and plans were made accordingly. Microwave radio has been proved dependable for varied services. For more than 10 years it has flashed Western Union telegrams between New York, Philadelphia, Washington and Pittsburgh with a record far better than that of land lines. Both the Pennsylvania and New Jersey turnpikes use it for traffic supervision and communication; the Arkansas Game & Fish Commission keeps in contact with its roving wardens with it; and it is utilized by the Atomic Energy Commission, City of San Diego, Calif., and in numerous industrial operations. Microwave is not subject to the physical limitations of wire, poles and insulation, nor to the cost and difficulties of traversing rugged terrain. It is not affected adversely by wintry weather because ice can't form on a radio beam. Excesses of temperature, dust and storms do not prevent it from operating reliably.

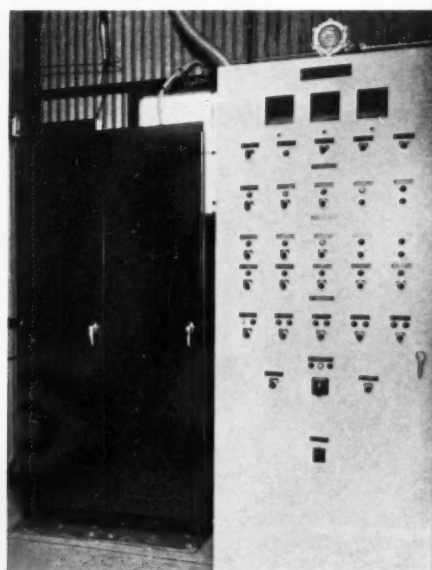
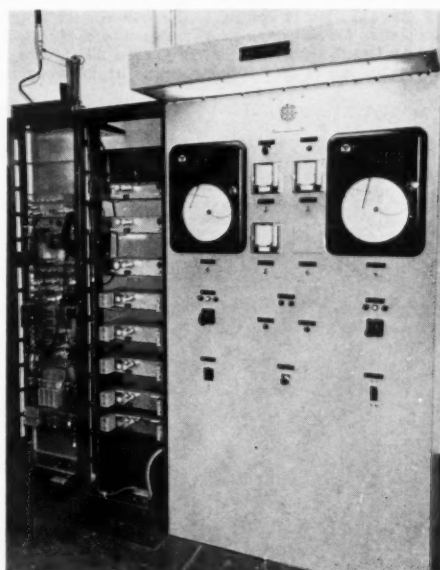
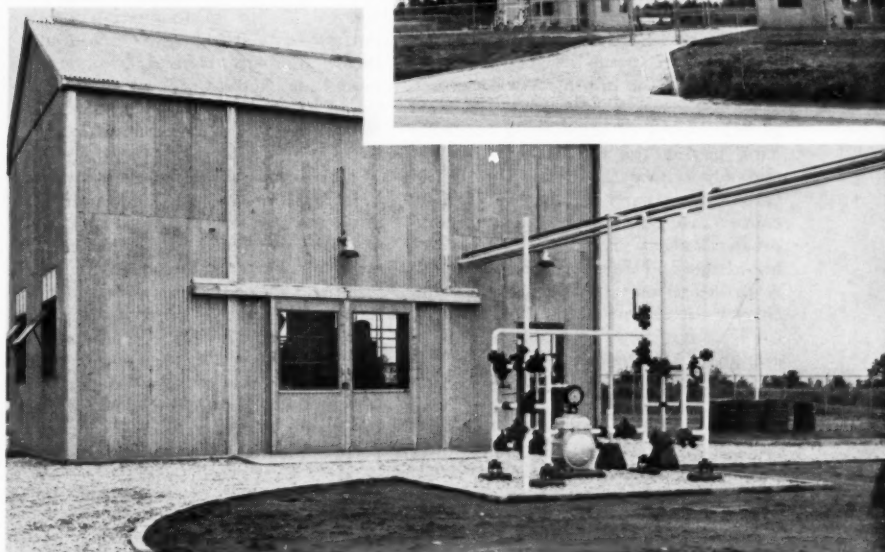
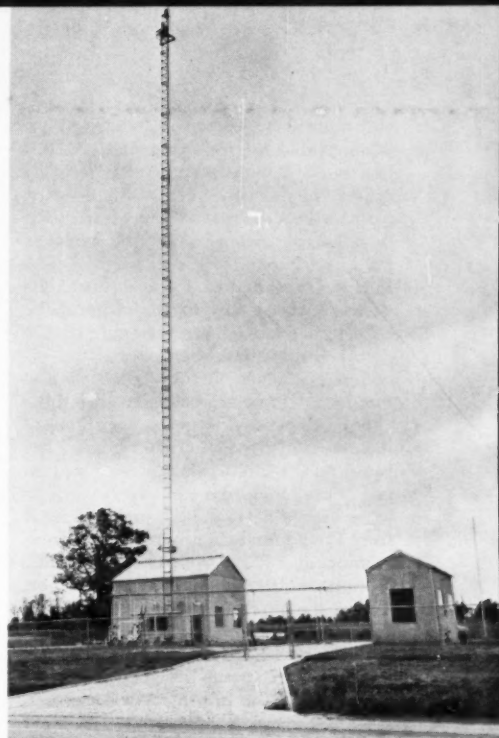
Because any function that can be converted to an electrical impulse can be

REMOTE CONTROL EQUIPMENT

The microwaved signals originate at the "Nelex" board (right) in the Gainesville office and are transmitted to the station panel (far right). They originate a control cycle that automatically starts, supervises and stops the booster-compressor unit. The station is entirely unattended. The cabinets adjacent to the panels contain the radio equipment which includes radio phones. When the compressor is running, lights and gauges on the boards give essential operating information and the two recording charts on the Gainesville board provide a record of the pressure and volume of flow of the gas as it reaches the terminal of the pipeline at the Gainesville border.

SATELLITE STATION

Radio waves are beamed 15 miles from the Gainesville tower (left) of Georgia Gas Company to the station tower (right). At the station, a remote-controlled engine compressor in the larger building boosts natural gas pressure to increase the capacity of the natural gas line leading into Gainesville. Radio control equipment is located in the smaller building. The view below shows the metering station in front of the compressor building where gas is taken from the pipeline and reduced in pressure for station use. Besides its job of fueling the engine compressor where it is utilized at a few inches of water pressure, some gas also serves at 150 psig to operate air motors used in starting the engine-compressor.



transmitted by microwave, the medium is adaptable for reporting and controlling such things as pressure, temperature, engine speed, etc., as is done at Gainesville. Microwaves may be focused in a narrow beam, much the same as light is focused by a searchlight. The microwave signal is beamed from one point to another by means of parabolic reflectors elevated on towers. In the Gainesville system, the tower at the gas company's office is 150 feet high and unguyed. Its vertical elements are three tubular legs tied together with cross members at frequent intervals. The tower at the satellite compressor station is 175 feet high and guyed.

The system operates under license from the Federal Communications Commission at 1875 megacycles in one direction and 1915 megacycles in the other. The stations are designated as KIV 93 and KIV 94. Sixteen tone units, each at a different frequency, are multiplexed on the voice channels assigned to permit transmitting the information desired.

United Cities Gas Company assumed general charge of engineering the facilities, buying the necessary equipment and supervising its installation. Because the company had never previously constructed or owned a pipeline compressor station, it did not possess the knowledge and experience necessary fully to design one. It consequently decided to delegate this function partially to concerns with considerable background in this field.

An Ingersoll-Rand Type SVG gas-engine-driven compressor had already been chosen as suitable for the transmission conditions. It has eight power

cylinders and four single-stage compression cylinders and is rated at 440 hp at 800 feet altitude. At the design conditions of 100-psig intake pressure and 550-psig discharge pressure, its capacity is 3,500,000 cubic feet a day.

It seemed to the management that the job could be simplified by equipping the compressor as a "packaged" unit, complete with auxiliaries. Such a skid-mounted unit could be moved intact and installed with a minimum of inconvenience and expenditure of time. It was not chosen with an idea of later shifting the unit to another location. In fact, it is foreseen that someday a second similar compressor will be required and the station has been designed so that one can be added readily.

United Cities accordingly sought the services of a concern that was experienced in building packaged machines, and this led to its designation for this purpose of the Stearns-Roger Manufacturing Company, Denver, Colo. At the same time, Radio Corporation of America was named to supply and install the radio control and communication system.

To coordinate the various operations involved, a meeting in Chicago of representatives of the principal equipment suppliers concerned was called by Mr. Ray. There, the Ingersoll-Rand and Stearns-Roger engineers worked out the mechanical details of the compressor unit and informed the RCA representative what his company's equipment would have to implement. Also participating was an engineer from Nelson Electric Company, of Tulsa, Okla., which had been named a subcontractor by RCA

to design and build the control boards that would be required.

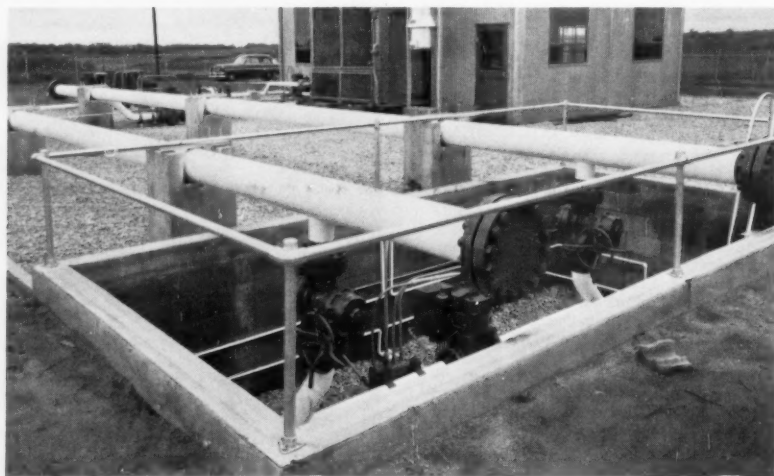
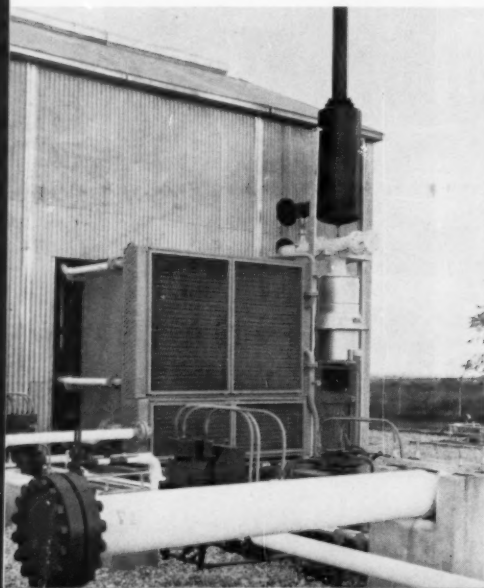
So that Stearns-Roger might assemble the packaged compressor in its Denver shops, Ingersoll-Rand shipped the machine there from the factory at Painted Post, N. Y., where it had been built. The auxiliary equipment required had meanwhile also been delivered to Denver. The principal items involved were a Smithco induced-draft, vertical-discharge cooler for cooling engine and compressor jacket water, lubricating oil and discharge gas; Amot temperature controllers for the jacket water and lubricating oil systems; a jacket water surge tank with necessary accessories; a fuel gas surge tank; a flywheel guard; a Burgess-Manning exhaust silencer; an American Air Filter Company intake air filter; a Peco full-flow oil filter; a suction scrubber for fuel gas; a Jerguson gauge glass; a Magnetrol high-level shutdown and Nicholson drainer; Mercoid high- and low-level shutdown switches; pressure gauges with pulsation dampeners; stainless steel thermometer wells with dial-type thermometers for all services; and all necessary piping for gas and utility services.

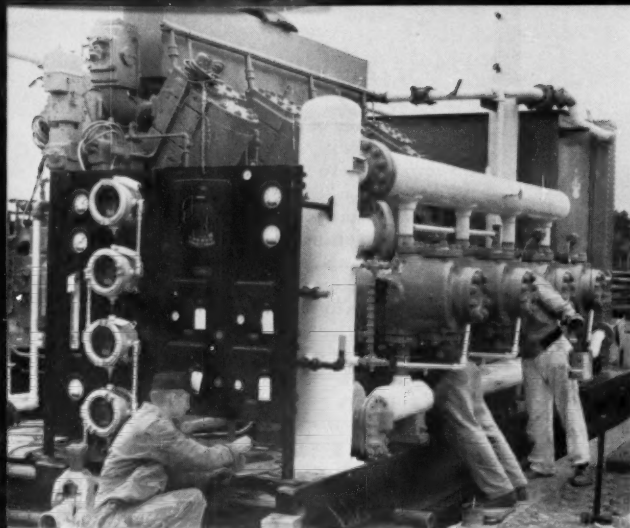
All these, plus the compressor, were mounted compactly on a steel base. The completed unit—approximately 10 feet wide, 25 feet long and 12 feet high and weighing almost 78,000 pounds—was shipped by rail from Denver to Jefferson, Ga., about 7 miles from the job site. The rest of the journey was made by tractor and Lo-boy trailer. Meanwhile United Cities Gas had started construction of the station and RCA had erected radio transmission towers there and in

STATION PIPING

On the 4-inch gas line from Bogart to Gainesville that is exposed in the pit in the foreground (right), there is a block valve that is air-operated. When the booster compressor is operated, this valve is closed and the gas is routed, through the piping shown, into the station for compression, then back out and into the line in the pit on the downstream side of the valve. In the close view at the left is the Smith-

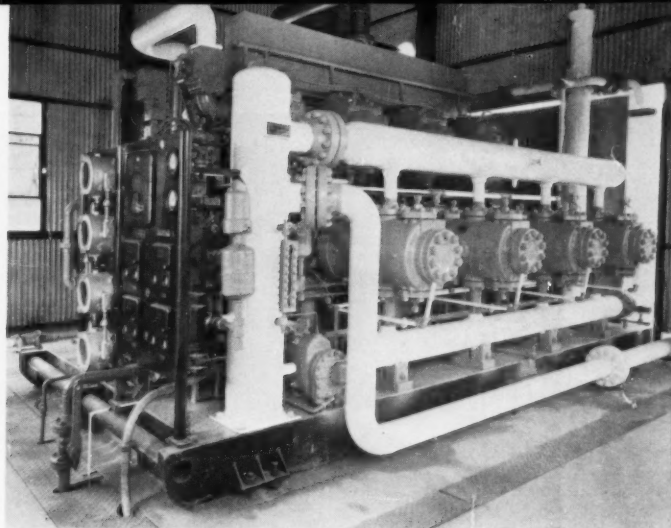
co heat exchanger that is an integral part of the "packaged" compressor. It cools the jacket water, lubricating oil and the gas after compression. The filter on the air intake to the compressor engine and the silencer on the engine's exhaust are shown at the right of the cooler. Shafer-operated Nordstrom valves on the yard piping are also visible in the foreground of this view.





PACKAGED COMPRESSOR

The almost-finished 39-ton, skid-mounted, Ingersoll-Rand Type SVG gas-engine-driven compressor and its auxiliaries shown in the Denver yard of Stearns-Roger Manufacturing Company just before shipment by rail to Georgia.



THE COMPRESSOR IN PLACE

The compact unit was quickly set on a concrete foundation in the station building. Daylight shows at the right end, where the heat exchanger extends outdoors. The instrument panel and gas scrubber are shown at the left end.

Gainesville. In the larger of two Braden truss-type prefabricated steel buildings at the station, a concrete foundation, complete with anchor bolts, was waiting and the compressor was placed on it and grouted in place. In the smaller building, RCA installed the radio equipment and the Nelex instrument board for controlling the compressor. This building also contains auxiliaries such as power supply panels, stand-by generator and an instrument air-supply compressor. Corresponding equipment was put up in the gas company's office in Gainesville. When everything was in place, the system was operated and checked. With so many elements involved, this was a rather complicated task and numerous adjustments were required before smooth working was assured.

One of the adjustments reduced the time required for starting. As the compressor building is unheated and the ambient temperature may drop below freezing, a thermostat-controlled 5-kw electric immersion heater was located in the crankcase to keep the oil at approximately 50°F temperature. However, after the engine fired, about an hour elapsed before the oil and water temperatures were high enough for loading the compressor. This unsatisfactory condition was remedied by the use of a relay to bypass the thermostat during the engine warm-up cycle.

Construction was started in August 1957; first tests were made in December; and final tests, the following month. The system was thus ready for service before the arrival of the coldest weather, which usually comes in February and March. It functioned without fault the few times it was called upon. The gas pressure at the Gainesville town border normally holds at no lower than 460 psig but on cold mornings it has occasionally dropped

ped to around 100 psig. This can no longer happen. Last March 4 the pressure at 3 a.m. was close to 500 psig. About 7 o'clock, when the load increased, it started dropping fast and was down to 230 psig by 9 o'clock. The compressor station was put on the line, and by 10 o'clock the pressure was back up to 360 psig.

In the station yard, the 4-inch line is exposed for several feet in a pit. A block valve is installed there and is normally open, permitting the gas to flow by the station unimpeded en route from Bogart to Gainesville. When the compressor station is operated, the block valve is closed automatically, thus blocking the through line. The gas is then diverted into a transverse header above ground and from it to the compressor intake. After passing through the compressor, the gas, its pressure increased, enters another header, which conveys it back to the pit and into the through line on the downstream side of the block valve. The block valve is of the Shafer air-operated type, as are four others on the yard piping, designated as suction, discharge, vent and bypass. Their functions will presently be described.

When the operator in the Gainesville office throws the master control switch on the board to the *Start* position, a microwave signal is beamed to the station and the starting relay on the Nelex control board there is energized. The board then takes over and directs the engine-compressor through the following sequence:

An air-motor-operated prelubricating pump is started and runs for 4 minutes, after which the engine is cranked by an air motor that engages a ring gear on the flywheel. Actually, natural gas, and not air, drives these motors. After cranking has proceeded for 10 seconds, magnetos

are ungrounded and 3 seconds later the fuel is turned on. As soon as the engine fires, which is indicated by a sudden rise in the oil pressure to 40 psig, the cranking motor is turned off. At this time, the Woodward engine governor is pneumatically loaded to maintain minimum speed. During a warm-up period that follows, the unit is not on the line. The bypass and vent valves are open and the suction and discharge valves are closed. The engine runs under these conditions until the crankcase oil reaches a temperature of 100°F and the jacket water, a temperature of 120°F. Then the suction bypass, vent and discharge valves are actuated in the proper sequence and finally the block valve closes and the unit goes on the line. At this point, the engine governor receives its pressure signal from a pressure controller and the engine speed is automatically varied to meet the demand. A pneumatic unloading control is also provided to unload the compressor cylinders as the intake pressure varies.

During the starting sequence, its progress is shown by lights on the remote control board in Gainesville. If all temperature and pressure conditions are normal and the Shafer valves are in their correct starting positions when the main power switch is closed, a green light shows. As the sequence starts, the green light goes off and a white light comes on. When the compressor is on the line, a red light shows and the white light is off. The board also shows the position of the station block valve, the engine speed and the gas pressure on the intake and discharge sides.

At the edge of Gainesville, the gas line goes into a "Town Border" station. The gas pressure is there reduced to 50 psig. It is further reduced at district regulating points to 10 psig and flows to



STATION AUXILIARIES

Standby electric generator (left) and 3-hp motor-driven compressor that provides compressed air for station use. The generator cuts in automatically in case of a failure of power from utility lines.

the customers' service regulators and meters and thence to the burners at about $\frac{1}{4}$ psig. Two pieces of information are telemetered from this station to the Gainesville office by Bell Telephone System wires and shown on charts on the control panel: the pressure of the gas arriving at the Town Border station and its flow or volume, from which the current usage can be computed. The first of these indicates when additional gas is required to meet the system demand and it can be provided within half an hour by the simple maneuver of turning a knob on the panel.

When the compressor has built up the line pressure at the station to a set maximum, the unit is shut down automatically. The Gainesville operator will normally shut it down at the board. In this case, the station's Nelex control panel slows it down, unloads it and takes it off the line in timed steps that are performed in reverse order to those of the starting sequence. The Shafer valves on the yard piping are then returned to their starting positions.

While the engine is running, a warning and emergency shutdown control system is in operation. The protective features incorporated in the "Warning" circuit will indicate any of the following troubles if they occur: (1) high lubricating-oil temperature; (2) low control-air pressure; (3) low lubricating-oil pressure; (4) high jacket-water temperature; and (5) high liquid level in gas scrubber.

An emergency shutdown will be caused by further fault in any of conditions Nos. 2, 3, 4 or 5 in the foregoing list and also by any of the following: failure to fire during starting, incomplete sequence of valve operation during the loading cycle, engine overspeed, high discharge gas pressure, low gas intake pressure or low oil level in the engine lubricator. The reason for the shutdown will be indicated on the station board and must be cor-

rected before the engine can be restarted.

In the case of either a warning or an emergency shutdown condition, the Gainesville board will show a light (amber for "Warning," red for "Emergency Shutdown") and a horn will sound, but the cause will not be indicated and a visit to the station will be required to learn it. When the "Emergency Shutdown" alarm is given, the operator in Gainesville silences the horn, turns the master switch to "Off" and pushes a "Reset" button. He then initiates the starting sequence again. If the trouble that caused the shutdown has been remedied, the unit will start in normal manner; if not, the engine will not start and the red "Emergency Shutdown" light will still show. The station must then be visited to ascertain and correct the trouble.

A selector switch on the panel board at the station allows the operator to override the microwave control and operate the compressor by local control. Or, he can operate by manual control alone in the event that the power supply to the control panel should fail. Power normally comes in over utility lines, but an Onan 10-kva, 115-v generator driven by an internal combustion engine is available as a stand-by. An automatic line-transfer switch will put this unit in commission when it is needed.

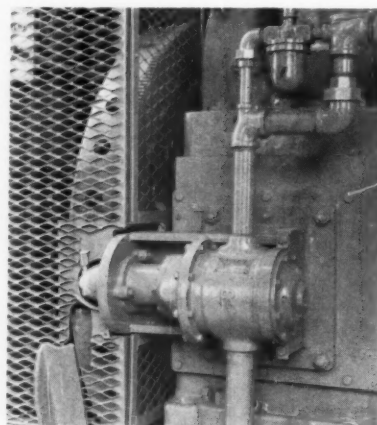
The compressor building at the station is 24x30 feet in plan and 18 feet high. The compressor is arranged crosswise of it with one end extending through an 11x11-foot opening. On the outside is the Smithco cooling equipment, an induced-draft heat exchanger that works on the principle of an automobile radiator. It is 71x92 inches in plan and 99 inches high and divided into individual sections for the three cooling services it performs. Cooling air is blown across the tubes by a 4-bladed fan driven by V-belts from the main shaft.

The uses of gas in the Gainesville area are varied. The city, which owes its existence to an early gold rush, was founded in 1818, is the seat of Hall County and has a population of approximately 12,000, although the territory served contains about 25,000.

Many homes use gas for space heating, water heating, cooking, refrigeration and air conditioning. Several textile mills require large amounts of steam for sizing fabrics and gas is used to generate it. Laundries are also good customers. Some of the large industrial concerns purchase gas on an interruptible basis.

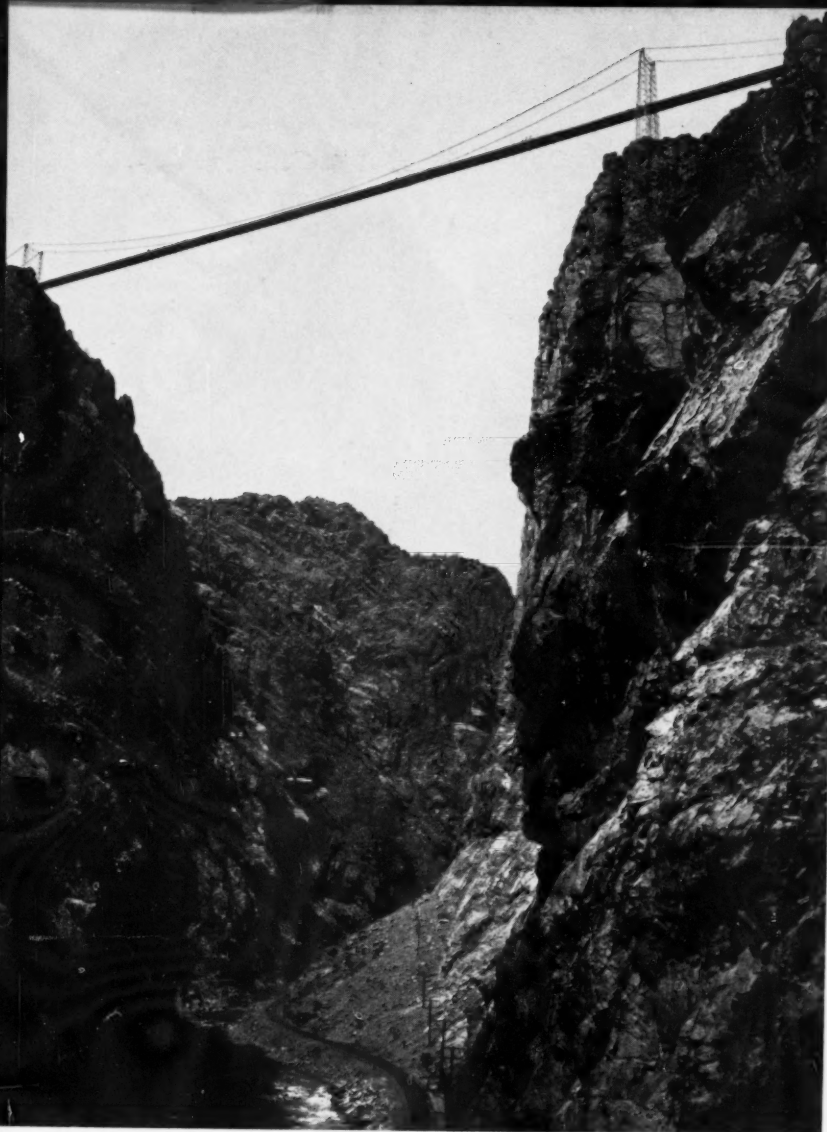
Another important consumer of gas is the chicken-processing industry, which is the area's leading source of revenue. The front plate of practically every locally owned automobile identifies Gainesville as "The broiler capital of the world"—about 4,000,000 are processed and shipped weekly.

The broilers have revolutionized the community's economy. Thirty years ago, North Carolina had one cash crop, cotton. Farms were run down and Gainesville merchants weren't faring well. In contrast, Department of Agriculture figures show that Georgia, which in this case means the northern hills around Gainesville, has led all the states in chicken production for the past 7 years. Last year, 261 million birds were shipped to supermarkets, restaurants and hotels of the nation—151 million more than second-ranking Arkansas. The gross income from the chicken crop was the state's highest for any agricultural commodity, and it topped, by \$7,000,000, returns from chickens raised in the Del-Mar-Va area of Delaware, Maryland and Virginia, which formerly held the top spot.



STARTING MOTOR

Ingersoll-Rand 20BM air motor connected to the flywheel of the engine-compressor through a Bendix drive. It was at first intended to operate the motor with station air at 100 psig but, to gain a more positive starting effect, it is being run with natural gas at 150 psig.



ROYAL GORGE

Carey Holbrook

ROUTE OF THE DENVER & RIO GRANDE

Spanning the nearly perpendicular walls of Royal Gorge is a suspension bridge, built in 1929 and extending nearly $\frac{1}{4}$ mile. It swings gently 1055 feet above the tracks of the D & RG. The floor of the bridge is built to support 2,000,000 pounds and is made of fir.

Even if the patrons are not concerned with the water question, the president of Royal Gorge Bridge Company, Ralph Wann, and his superintendent, Levi Reeves, make up for it by lying awake nights with the problem on their minds. In an organization such as is maintained by the company, it takes 5000 gallons a day to keep the drinking fountains spouting and the taps running.

Two pumps are installed at the bottom of the gorge at the water's edge, although only one of the units works at a time. It pushes water through a $1\frac{1}{2}$ -inch line a distance of 1750 feet. The entire pipeline hangs almost perpendicular, with none of it at less than a 45-degree angle, with a total vertical lift of about 1100 feet. Storage tanks on top have a capacity of 15,000 gallons—a 3-day supply. A small secondary pump at the tanks distributes the water throughout the park.

More interesting is the history of Royal Gorge. It is not a recently discovered tourist attraction; and it is not something that was dug in a day. Geologists generally admit that the gorge is about the deepest ditch they know that was excavated entirely by erosion, the Arkansas probably having spent more than 4,000,000 years doing the job. They estimate that the rate of progress in digging was approximately 400 feet every 1,000,000 years.

There does not seem to be any definite record of who first saw the gorge, but it has been popular with tourists since the high bridge was built by Lon Piper in 1929. Since 1947, when the operation was assumed by the present management, it has become a major attraction.

The gorge and the land surrounding it, known as Royal Gorge Park, belong to Canon City, having been ceded to it by an act of Congress in 1906. That portion of the area on which the buildings stand, on both sides of the ditch, is leased by the Royal Gorge Bridge Company under a long-term agreement.

During the tourist season, more than 140 people are on the payroll. Two offices are maintained, one at Canon City, and the other, at the gorge. At the latter, in addition to three office workers, there are parking lot men to keep order among the thousands of cars that cluster around the area, maintenance men, forest rangers who meet cars to explain the high lights of the area, bumper boys who attach signs to cars

ON an average day during July and August, between 4500 and 5000 people pass through the gates that lead to Royal Gorge, a mighty crack dug in the mountains near Canon City, Colo., by the Arkansas River. They mill around on top of a rocky pinnacle and go to the bottom of the gorge on what may well be the steepest railway in the world. They walk or drive over the highest suspension bridge in the world, from which they can look straight

down at the Arkansas River, foaming 1055 feet beneath them; visit five curio shops, where 115 people are employed; and eat at the Cliff Terrace Restaurant, perched on a rocky knoll just across the bridge and overlooking the gorge. They drink from modern fountains and wash their dusty faces in modern restrooms, yet few give a second thought as to where the water comes from. Very likely, few give any thought to the history of the gorge itself.

AN INCLINED RAILWAY

The picture at the right was taken looking up the 1550 feet of the incline railway at Royal Gorge. It carries as many as 40 passengers at a time in its two cars, from the park site at the top to the water's edge. It was built in 1931 at a cost of \$200,000. The break in the narrow canyon just to the west of this split is the passage probably used by Zeb Pike as an exit from the gorge. To the right, at the top of the photograph, can be seen the center portion of the 18-foot-wide suspension bridge. The illustration below shows the control tower for the railway. Automatic control and safety features, two passenger cars weighing 4500 pounds and a cable strength of 112,000 pounds have combined to make this run one of the safest in the world—there has been no passenger accident since its first trip was made.



and many others. However, only two families live at the site the year around.

Some idea of the magnitude of the operation may be realized from figures on the printing required. Some 150,000 bumper tags, 200,000 daily programs and 400,000 brochures explaining the points of interest are used annually.

The suspension bridge is said to be the highest structure of its kind in the world. It is 1055 feet from the floor of the bridge to the river. The distance from one end to the other is 1260 feet, almost a quarter of a mile. Each supporting cable contains 2100 strands of galvanized wire and weighs 300 tons. The floor is made of 3x12x18-inch fir planks that are renewed as necessary. O. K. Peck, consulting engineer at the building of the bridge 29 years ago, is still active in his profession and lives in Denver, Colo. Every 6 months, he makes an inspection of the structure and recommends any repairs he thinks necessary.

Naturally, such a long, suspended structure is subject to vibration from wind, and in this case, traffic. Thus, it was impossible to lay a steel pipe across it to carry water to the installations on the other side. After 3 years of experimentation, Gates Rubber Company developed a special rubber pipe for the project. It is sun resistant and pliable enough to withstand the vibration, and delivers the water, free from



discoloration or foreign taste. Since the restaurant is the principal user and closes in October for the season, the pipe is removed for storage each fall.

In April 1957, a freak snow storm blanketed the area, the wet snow breaking all power lines and cutting all communication. An emergency crew went into action to clear the bridge and relieve it of the immense weight. The two families living at the park were without heat, light and water for several days. There was no break in the water lines, however, for they had been drained.

One of the attractions at Royal Gorge is a ride to the bottom on the inclined railway. Most of the visitors, as they make this trip to the edge of the water, are likely to worry, although no accident to passengers has ever occurred in the operation of this unique line. The train's two cars have a capacity of twenty passengers each, and it takes 5½ minutes to make the trip, in either direction.

The track is laid on the rocky floor of "Telephone Gulch," a break in the canyon wall that was the only feasible place the line could be laid. Not far

west of this cut is another narrow break that is thought to be the route taken by Lt. Zebulon Montgomery Pike through the gorge in 1806. According to his diary, Lieutenant Pike left St. Louis, Mo., on an exploring trip in which he was trying to find the headwaters of the Arkansas and Red rivers. On December 5, 1806, Pike and a party of 22 men arrived at the gorge. Because of the rough country and the snow and mountains, it was not an exceptionally pleasant trip. Nevertheless, no matter how cold Pike's fingers became, he managed to keep an accurate daily account. Early in 1807, he made an attempt to walk through the gorge and his diary records the effort in the following:

Jan. 4, 1807. I determined to continue down the river alone until I could kill some provisions—for we now had no food left and everyone had to depend on his own exertions for safety and subsistence. I marched on about five miles down the river which was one continuous fall after another thru a narrow channel with immense cliffs on both sides. Near

night I came to a place where the rocks were perpendicular on both sides. I discovered one of the men of the other party and he and his companion joined me. They said they had not known where the rest of us were—that they had eaten nothing for two days and this night they intended to have boiled deer skin to subsist on. We discovered a narrow ravine which we ascended with the utmost difficulty and danger—wounded a deer but in the darkness of approaching night could not find him; when I returned hungry, weary and thirsty and had only snow to supply the calls of nature. Distance advanced, eight miles.

It was on this trip that Lieutenant Pike sighted the famous mountain that is now called Pike's Peak, and the narrow ravine to which he refers is probably the first cleft in the canyon wall west of the one called "Telephone Gulch."

The inclined railway was built through the gulch in 1931 at a cost of \$200,000, and 8 months were spent in its construction. It is 1550 feet from top to bottom, and it hangs at a 45-degree angle. Building this line was a construction feat that required concrete pillars to be set into the solid granite. On these, steel beams were placed to support the rails. Materials and men were lowered on steel cables from the cliffs while the work was in progress.

Probably the most spectacular event



WHEN THE SNOWS COME

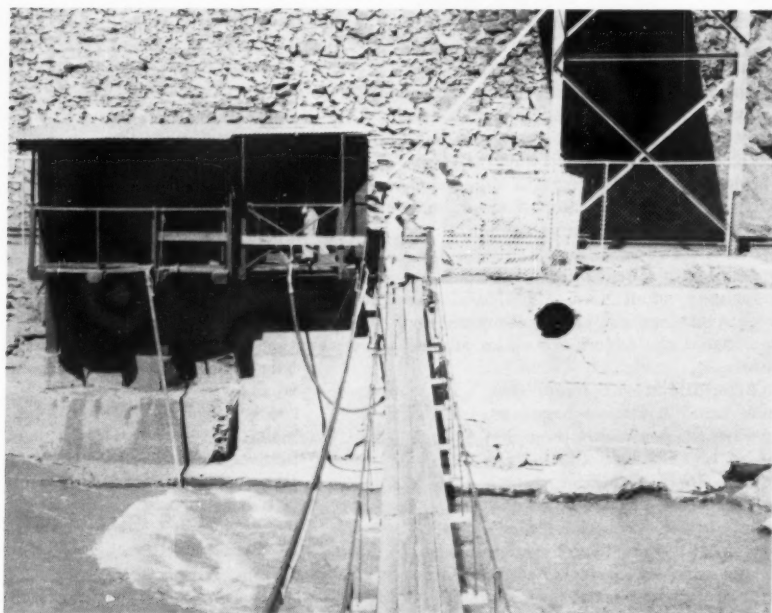
Swinging far above the gorge, this 1260-foot-long suspension bridge is thought to be the world's highest such structure. Each supporting cable contains 2100 strands of galvanized wire, and its 3x12x18-inch fir planks are said to be able to withstand a load of 2,000,000 pounds. A freak snow fall in April 1957, however, had to be quickly cleared so that the excessive weight and wind vibration would not destroy the bridge. An indication of the depth of the wet snow can be seen along the guard rails in the illustration at the right.

in the history of Royal Gorge was the battle between the Santa Fe and the Denver & Rio Grande railroads in a dispute over the right of way for tracks through the gorge. For a long time, each of these roads had been eying the gorge as its own passage through the mountains to reach the rich country to the

west. It was not until 1878, however, that the two met, head on, in an effort to secure this route for themselves. In April 1878, ten members of the Santa Fe engineering crew swam the icy Arkansas and took possession of the eastern portal of the gorge, apparently intending to start construction of their railway at once. For some time, surveying crews of the D & RG had been working with the same idea, but this move on the part of the Santa Fe blocked further work at the entrance. They moved farther up the gorge to continue their work. The walls were closer together and higher there, causing their work to be most hazardous. The dispute became more serious; each side built forts; and gunfire was exchanged—however, there is no record of any lives being lost. The problem, of course, finally got into the courts where eventually the Denver & Rio Grande won the case.

For many years, this route has been one of the scenic wonders enjoyed by travelers between Denver and Salt Lake City, Utah. On this trip, trains stop midway through the gorge at the site of the carrier's famous hanging bridge, so passengers can look up more than 1000 feet to the suspension bridge.

The hanging bridge itself is one of the unique engineering problems encountered by the D & RG road builders. At this point, the canyon is so narrow, and the perpendicular walls so high, that no possible room could be found to lay the track, or build approaches to a bridge. The problem was solved by hanging the structure across the stream from cliff to cliff. Across this hanging bridge, the trains of the Denver & Rio Grande still travel today.



PUMP HOUSE

Hanging over the Arkansas River, the pump house in this illustration contains two pumps that work one at a time. They furnish water for the park, some 1750 feet above, through a 1½-inch line swung at a 45-degree angle. At the top, secondary pumps distribute it from 15,000-gallon-capacity tanks. The 30-inch-wide footbridge seen in the foreground is hung across the stream's deep and swift current on a wire cable.

WAKING in the morning to hear snow shovels grating across the sidewalks is a familiar experience for most people of the temperate latitudes. In some parts of the world, the whisk of cutters and the sound of horses pulling them is equally well known. The snow, that makes these as well as many other seasonal activities possible, is a common sight; it is surprising that snow is a relatively unstudied wonder of nature.

Snow is ever-changing in form and design, both on the ground and in the clouds that surround the world. A series of atmospheric changes causes it to fall. Once on the ground, the changes take place at once and may be completed within a few minutes, or may require days, weeks or even months, depending upon the climate, altitude, exposure to the elements and, not of least importance, the quality and density of the snow itself. This metamorphosis is called, by glaciologists, firnification. The word is derived from firn, or old snow, which technically refers to a more-or-less compacted snow of small, rounded crystalline grains formed from the snow crystals. The term is applicable until the snow has completely melted or has become compacted into a totally frozen ice mass, as in the case of a glacier.

Firnification starts with settling. The underlying pieces of crystal begin to crumble under the weight of the upper snow layers. This is aided by sublimation, that is, the cycle by which the solid ice crystals vaporize to reform as a solid on the upper layers. Thus the top snow gains in weight, speeding the process of compaction. The effect can be readily seen by a marked decrease in the over-all depth of the fall and an increase in its density.

The density of a fresh snow depends not only on the type of crystals that form it, but upon wind. When the temperature is below freezing and the air is still, millions of tiny crystals gently settle to earth, holding themselves apart from each other. Such a snow may have a specific gravity of about 0.06, although that of the ice that makes up the crystals is as much as fifteen times heavier. A fluffy snow contains about 97-percent air. In contrast, a wet, heavy snow is formed when the winds have hurled the crystals together into a thick, matted mass. There is only about 30-percent air in such a ground cover, and the blanket it forms is firm and dense.

Singly, snow crystals are practically weightless. However, it has been estimated that a 15-inch-deep snowfall, over an area 5x100 feet in size, weighs 3900 pounds, depending upon the proportion of air and ice in the snow, and the amount of its compaction and sublimation. A 6-inch layer of moist new snow,

or a 30-inch fall of dry, fluffy snow, is approximately equal to 1 inch of rain. Thus, if an acre were covered with, say, 30 inches of dry snow, it would exert a pressure of 113 tons on the ground. It is clear then why snow stops trains, halts automobiles and annually crushes millions of dollars worth of property.

The mass and density of snow are of special importance when considering snow removal—a problem that faces not only the average man with but a few feet of sidewalk to clear, but cities that must keep their miles of highways free for traffic. It is a multimillion-dollar job. In the state of New York, for example, where the annual snowfall ranges between 50 inches in the upstate areas to about 30 inches in the southern sectors near New York City, the cost of snow removal and ice control surpasses \$6,000,000. New York City alone utilizes 20,000 men and 4300 trucks and plows to remove the snow from its 5000 miles of streets. When a blizzard strikes, these figures are multiplied manyfold.

Perhaps the most famous of all blizzards in the eastern part of the United States was that which fell in March 1888 and crippled New York City. It paralyzed all activities, the most notable exception being the uninterrupted publication of *The New York Times*. For that reason, we have a vivid account of the disaster. Wind and rain first covered the city and the temperature fell rapidly. By the end of the first night, sleet and snow began to take their toll; in the morning, the blizzard was firmly established. The wind circled about, seemingly without direction, over a 20-mile circle, the center of which was the island of Manhattan. The streets were piled with as much as 15 feet of snow, and narrow alleys were impassable. Fires broke out from overheated stoves. Yet, according to *The Times*, there was an amazingly small loss of life, and the people, strange as it may seem, rather considered the experience as an adventure.

After the storm, some 1000 men and 700 wagons began to remove the snow, dumping the white blanket into the nearly frozen North and East rivers. Fear that they might flood was soon proved to be unfounded, and a city that looked much like an Arctic outpost began to resume its normal way of life.

New Yorkers called the Blizzard of '88 an adventure; it is only one type of snow-born romance. Climbing the world-famous glaciers, following the tracks of reported dragons, abominable snowmen and strange inhabitants of snow-bound areas have appealed to the

adventurous for centuries. Others find a challenge and a thrill in skiing and sledding; others, in making snowmen. Some look at the over-all snow scene by tracking storms, surveying snowfalls and the like; while others find adventure in isolating the individual snow crystals for study.

Skiing is universally popular. Xenophon, the Athenian historian-general, refers to the use of ski-type shoes worn by horses to prevent them from sinking into the snow. The Laplanders were first known as Skrid-Finnen, or sliders. Even the Chinese recorded, in the eighth century, the details of hunting game on ski among the Kirghiz tribes in Turkestan. Ski have been adapted for battle from very early times, and today many armies of the world have specially trained ski troops, best known of which are those of Norway, Sweden and Russia. The United States and Canada have led the world in skiing sports, including proficiency meets, hiking, jumping and cross-country racing, with Canada holding the honors for the best, over-all development.

Another means of getting over snow-



S N O W



covered ground is sleighing. At one time it was the only means of transportation during the winter, and as with most forms of transportation, team races were devised to test the skill of horse and man. After the Civil War, racing teams no longer challenged one another, and sleighing became a sport of individuals thirsting for speed. Their efforts were as popular as horse-racing is today. With the advent of the automobile and highways to accommodate them, sleighing lost the position it once held.

Akin to sleighing is tobogganing. Long a favorite winter sport, it is still gaining in importance each year. The 'sleds are from 3 to 8 feet long and from 2 to 3 feet wide. They are formed of strips of wood fitted and curved at the front. On big, specially constructed chute runs where high speeds are the rule, steel-skeleton 'sleds are used, and the riders are equipped with steel-spiked boots for steering and braking.

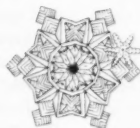


Most children are content with simpler winter adventures that include making snowmen. Some adults consider snow sculpture seriously, most noteworthy being the men at Dartmouth College in Hanover, N. H., where deep snow and low temperatures permit sculpture that is much more elaborate in scale and detail than the stacked snowballs of children's snowmen. The finished figures turn the campus into a "winter wonderland."

Snow sculpture gained its first reputation in the United States in Brattleboro, Vt. Larkin Mead, a clerk in a hardware store, with a hobby of making figures out of soap, made his first snow angel on an impulse on New Year's Eve, 1857. Two years later, he made another that was more spectacular and which established him as a snow sculptor. Incidentally, after fashioning the first and noting its success, he left his clerk's job to study sculpture in New York. There, he assisted his professor in producing the statue of George Washington that now stands in Union Square, New York City.

Men of the Weather Bureau take their wintry adventures in earnest—they

At each gauge site is a cobalt radiation source placed just below the surface of the ground, and a radiation detector 15 feet above it. The radiation emitted by the cobalt is absorbed by the snow in proportion to the water content of the snow pack, not its depth.



Some scientists prefer to look, not at the mass, but at the individual crystals and wonder at their symmetry and their formation. This work probably began in Japan during the last half of the eighteenth century. Ranzan Ono is said to have used a "Dutch glass" to observe them.

Unfortunately, nothing of his published work remains. In 1832, Toshitsura Doi issued *Illustrations of Snow Blossoms* (*Sekka Zusetsu*), and 7 years later, a supplement was published with some 100 drawings of snow crystals. James Glaisher, an English scientist and founder of the Royal Meteorological Society, made balloon ascensions to report on the upper layers of air. In 1855, he published a work about his studies, and included in it were drawings of snow crystals remarkably like those produced by Doi. They are among the finest made without the use of a camera.

With the development of photomicrographs, snow crystals could be studied with more accuracy. G. Hellman, of Germany, and G. Nordenskjöld, of Sweden, studied thousands of such pictures and divided all crystals into three classes: plane; column; and a combination of the two. It is the basis of our more complex classification of today.

It was Wilson A. Bentley of Vermont who pioneered the art of photographing snow crystals. He became known as the Snowflake Man. At first, his 6000 pictures, taken during a 40-year period, were a novelty, but they later formed the font from which nearly every work on meteorology drew its illustrations. His book, *Snow Crystals*, is still a classic in the field.

Meanwhile, in the East, a year before Bentley's death in 1931, a Japanese scientist, Ukichiro Nakaya, joined the Hokkaido University as a professor of physics. Following a systematic investigation of snow based on the classification proposed by Hellman and Nordenskjöld, he devised the classification now in use.

There are seven basic types of snow crystals: needle; columnar; plane (hexagonal plate and stellar); combination of column and plane; columnar with extended side planes; rimed (crystal with frozen cloud particles attached); and irregular snow particle. Within these groups are 37 variations that can be regularly found in snowfalls, and countless others that are individual.

All snow crystals have, in general, certain attributes that are similar, no matter what their form. They all originate in clouds and are made of ice. They are transparent, for the most part, and have brilliant facets. However, their fascination lies not so much in their similarities, but in the fact that they are a product of nature's improvisation. Unlike most chemical compounds that exhibit a single crystal structure, each snow crystal shows a remarkable variation of structure from all the others. Each is a complex masterpiece of construction and precision, and most exhibit an amazing symmetry.

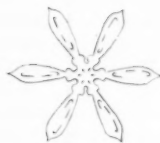
The word crystal is derived from the Greek *krystallos*, meaning ice. It was applied to mineral quartz which the ancients thought to be permanently frozen water. Now, it has a far different meaning and is associated with the behavior of molecules as they pile up in a regular way to create a solid.

To investigate the snow crystal, we must begin with the water molecule. Within its ten-billionth-inch size, it has one negative and two positive charges. Upon cooling, the weaker of these attract one another, the negative and positive being attracted to each other.

Thus, the many molecules of water in a single vapor drop combine to form the ice crystal. Because the charges are 120 degrees apart, a definite 3-dimensional geometric pattern is formed. Six overlapping hexagonal groups of molecules define the six sides of the crystal, while a seventh lies at the center. In this manner, the complex warp and weft of three's and six's weave a tissue of ice which laymen call a snowflake.

The crystals fall to earth in a variety of patterns, as we have indicated. The differences are caused by variations in water vapor saturation and air temperature in the clouds, not ground conditions, as was once thought. (It is also believed that the shape of the crystals is affected by the form of the speck of dust, or nucleus, to which the vapor molecules attach themselves.) When the temperature of the upper atmosphere is warm, the clouds' vapor content is high and the water molecules are more active. The crystal, consequently, forms quickly. Currents in the clouds jostle the crystals, causing them to do a variety of unexplained things, thus giving them their many shapes before their earthward journey.

In the final analysis, the adventure of winter makes it unique among the seasons. Despite the calendar, it takes a walk in the first snowfall to truly develop the winter spirit. The witchery of snow is so woven into our lives, especially at this time of year, that it is a rare man who will not agree that a Christmas that isn't white is a sad one.



S. M. Parkhill

are responsible not only for detailed maps and progress reports of storms, but have been the backers of many devices and theories that have helped us gain a better understanding of snow. Among their activities are the making of snow surveys. From them, relatively accurate forecasts of spring run-off and estimated reservoir capacities are obtained. At one time, such surveys were made by courageous men equipped with ski and showshoes. Today, the U. S. Corps of Engineers is experimenting with a system developed by Sierra Electronic Corporation whereby radiation and radio telemetering methods measure the water content of snows. If successful, it will mean that men will no longer have to go into remote areas for direct measurements.

Three gauge sites are utilized. Data taken from them are transmitted through two relay posts to a base station well removed from the heavy-snow regions.

WONDER DRUGS are nothing new. An ancient researcher, delving into the mysteries of his alchemy, discovered the first one more than 2400 years ago. Whether by his standards, or by ours, the phrase "original wonder drug" is most appropriate for his discovery. It was unquestionably the first remedy, chronologically, with the broad range of medical usefulness that fits today's popular definition of wonder drug. Even more amazing is that the drug is not only still in use, but is gaining increasing admiration and respect from the medical profession with each passing day.

The drug is aspirin, but the ancients didn't know it by that name or in its present form. Apparently, credit for the discovery of what the world now calls aspirin belongs to an unnamed doctor of 400 B. C., as he probed herbs and leaves to find a cure for diseases then termed *podagra* and *fistulus*. Then, as now, the medicine was used primarily to treat man's most common complaint—pain.

The leaves and bark of the willow tree were among the earliest natural sources to yield the family of salicylate chemicals, of which aspirin is the most popular. Indeed, aspirin is by far the world's most widely used medicine and, most physicians add, the most widely useful. If counted, the number of serious diseases and lesser ailments treated with it would amount to more than 200.

By the second century, boiled pastes and liquids made from willow leaves and bark were used for removing calluses and easing earaches. Such was the fame of their efficacy that even then these primitive salicylates were used as pain-relievers by Romans, African Hottentots and American Indians. As centuries passed, they were found helpful in a greater variety of human afflictions, including eye and skin diseases, liver ailments, worms, blood disorders, and, by the eighteenth century, rheumatism.

In the same period, doctors stumbled on a new action of the compounds. Fifty patients in an English hospital, suffering from "agues and intermittent disorders," were treated with powdered forms of dried willow bark. In each case, fever dropped to normal. Thus, the salicylates became known as fever-reducers, as well as pain-relievers. Dr. Ezra State

Something About Aspirin

announced the finding to London's Royal Society in 1763, thereby stimulating scientific interest in the drug for the first time.

Willow bark was carefully studied for clues to its wondrous makeup. In 1826, two Italian scientists reported finding an active ingredient that they called salicin. A few years later, a French colleague isolated the substance in its pure state. The search continued until a major breakthrough occurred in 1853. Charles von Gerhardt, an Alsatian chemist, synthesized acetylsalicylic acid—aspirin—in the same form we know it today. Ironically, neither science nor society gained any immediate benefit from the discovery, for Von Gerhardt,

young chemist, Felix Hoffmann, was confronted with an elderly father who was crippled with rheumatoid arthritis and complained of the unpleasant reactions stemming from the salicylic acid treatment he was receiving. Hunting through scientific journals, Hoffmann came upon a report of Von Gerhardt's discovery and, after studying its chemical properties, was convinced he had the answer. His solution proved not only effective in relieving the arthritic pains, but caused no side effects. Filled with enthusiasm, Hoffmann evaluated the new compound in other arthritics and constantly achieved the same results.

Medical history records the fact that aspirin, since 1899, swiftly came to be regarded as the universally preferred medication in arthritis. Perhaps more amazing is that, today, doctors still say it is "unquestionably the most useful" in combatting the disease and prescribe it in more than 80 percent of arthritic cases.

In the course of Hoffmann's clinical trials, he also learned that acetylsalicylic acid cured the headaches of the arthritic patients he was treating. Thus, by accident, was uncovered the indication for which aspirin has become universally famed.

Aspirin is credited in current, recognized medical journals as being recommended for virtually every disease from the common cold to cancer; a drug that relieves inflammation, fever and pain, reduces the crippling effects of arthritis, improves blood circulation, prevents kidney stones, relieves



being a chemist and not a clinician, knew of no practical applications for his finding.

The next milestone took place in 1874 with the synthesis by a German chemist, Herman Kolbe, of salicylic acid, aspirin's active ingredient. It was immediately hailed as an important therapeutic advance; but it proved to be a relatively short-lived triumph, despite a report from Dr. Franz Stricker, a Berlin physician, that salicylic acid appeared to be easing rheumatic pains and stiffness. Unfortunately, word came at about the same time that the new drug was responsible for various side affects.

The "second" discovery of acetylsalicylic acid took place in 1899 at Bayer Company's plant in Germany where a

sunstroke, acts as a mild sedative, controls rheumatic fever and, among other things, substitutes for insulin in diabetes.

Everyone recalls the world-wide Asian 'flu epidemic of 1957 and its great toll of victims. Since the infection was caused by a new strain of virus, the problem of prevention and treatment was a serious one to health authorities. In the United States, the Surgeon-General's considered recommendation was "bedrest, fruit juices and aspirin."

Among its multiple uses, however, none approximates the astonishing conclusions in two recent reports. Writing in the *British Medical Journal*, Dr. J. R. Reid described treating a rheumatic fever patient with large aspirin doses, only to learn the victim also had dia-

betes. To his surprise, the diabetic condition stayed under control although the patient was receiving no insulin.

Skeptical of the only logical explanation—that aspirin was responsible—Doctor Reid administered aspirin to seven diabetics. The original findings were confirmed. Without insulin, aspirin controlled the disease. Needless to say, the medical profession has yet to accept the validity of this report. On the other hand, the reputable *Canadian Medical Association Journal* urged that the hypothesis be studied because there are sound reasons to believe that aspirin

can "become a valuable antidiabetic agent."

Even more startling is a study published by a California physician respecting aspirin's action against heart disease. Dr. Lawrence Craven stated that not a single heart attack or "stroke" occurred among 8000 middle-aged and elderly men who were given small daily doses of aspirin through a 10-year period. This report, like the diabetes study, is unsubstantiated, but there is medical rationale to warrant further investigation. Aspirin is known to be a mild anticoagulant, and it is the formations of clots

in the arteries nourishing the heart and brain that trigger attacks.

All of this makes a story so impressive that the familiar white aspirin tablet, stand-by of the family medicine chest, is now the object of more scientific interest than at any time in its 105-year history. Nobody knows precisely why and how aspirin does what it does; it is truly a mystery drug. Aspirin is a riddle wrapped in an enigma. Today, medical science can say only that aspirin does many remarkable jobs; at the same time, it can only continue wondering how and why.

This and That

Added O₂ Aids Cat Cracking

Recently concluded tests of oxygen enrichment for catalyst regeneration conducted jointly by Linde Company, Division of Union Carbide Corporation and Cities Service Oil Company at the latter's refinery at East Chicago, Ind., were successful. From the data derived, it is calculated that feed-oil flow can be increased 15 percent while maintaining prior conversion rates. In effect, the oxygen addition increases cat cracker capacity. It can be compared to blast-furnace oxygen enrichment in that no capital expenditure to increase the physical dimensions of the equipment involved is required to boost output.

In the process of catalytically cracking heavy oil fractions to gasoline and other light petroleum products, a coke deposit is formed on the catalyst particles. This must be removed to maintain catalyst activity and is accomplished by continuously transferring a portion of the catalyst from the cracking chamber to a regenerator, where the coke deposit is burned with air at about 1100°F. A medium-sized cracking unit (say, 20,000 barrels per day capacity) generates about 20,000 pounds per hour of coke and requires more than 2500 tons per day of air to burn it from the catalyst. During regeneration, the total carbon content of the catalyst is reduced from about 2 to 0.5 percent.

In the Cities Service tests, oxygen additions to atmospheric air of up to 150 tons per day were used to bring total O₂ content of the regeneration air to 27 percent (weight). Most of the test data, however, were collected using oxygen additions of 100 tons per day. This brought the enrichment level to 25.5 percent (weight). Process control was said to be smooth and uniform over the entire range of enrichment. Coke burning capacity of the regenerator increased in proportion to the additional oxygen available for combustion. Temperature control, oxygen utilization (pounds of oxygen per pound of coke

burned), oxygen content in the flue gas and residual coke on the regenerated catalyst did not change appreciably from normal-air operating conditions. A trend toward improvement in operation performance was indicated when using higher oxygen concentrations. The net effect of adding 100 tons per day of oxygen was to increase the conversion of feed oil by approximately 5 percent (volume) at constant feed rate, or to increase the feed rate by 15 percent (weight) at a constant rate of conversion. In either case, the value of the additional product more than offset the cost of oxygen. The gas was brought to the refinery in the liquid state by trucks from Linde's plant in East Chicago.

★ ★ ★

5000 Feet Of Conveyor Belting

Hewitt-Robins, Inc., has received an order for more than \$700,000 for the design and manufacture of a conveyor system to be installed at a new iron ore shipping terminal being built at San Juan, Peru, a port on the Pacific Ocean, by Pan-American Commodities, South America. The order consists of seven conveyor units totaling about 5000 feet of rubber belting; also vibrating feeders, a traveling stacker, traveling shiploaders, recording scales, chutes, structural steel, motors and controls. At the San Juan shipping terminal, 40-ton bottom-dump trucks will discharge ore into a receiving hopper. The ore will be withdrawn from the hopper by a feeder, then transferred to conveyors and carried to a traveling ore stacker that will deposit the metal in stockpiles located on the ground and above a reclaiming tunnel. When a ship is ready to be loaded, the ore will be withdrawn by vibrating feeders and discharged to a conveyor inside the tunnel. Then it will be conveyed to a traveling shiploader and discharged into the ship's holds at a rate of approximately 2000 tons per hour.

An unconventional Cryopumping technique for producing Yields extremely high vacuums High Vacuum promises substantial savings for research and

industrial uses. It is already utilized for missile research in a University of Southern California wind tunnel and was explained to members of the American Vacuum Society at the recent Third National Vacuum Symposium in San Francisco, Calif. Called cryopumping, the technique calls for freezing a gas within a chamber, thus leaving a high vacuum. With temperature reductions of about minus 420°F, pressures of one-millionth atmosphere can be attained, it was reported by Bruce M. Bailey, of Arthur D. Little, Inc., and Dr. Raymond L. Chuan, Director of the University of Southern California's Engineering Center. Bailey and his colleagues at ADL developed the cryopump, and Chuan and his group, the wind tunnel installation now in use. The cryopump is essentially a low-temperature refrigerator, utilizing helium at about minus 420°F as the refrigerant. The system is used most effectively when combined with a mechanical system. Mechanical pumps are most efficient at lower orders of vacuum; whereas the cryopump gains in efficiency under high-vacuum conditions. Such a combination thus utilizes the advantages of both methods. The system is said to be economical enough for large-scale industrial applications.

The USC wind tunnel makes use of the technique to pull a high-velocity stream of nitrogen across a test model in the wind tunnel. The nitrogen stream is frozen at one end of the tunnel, thus creating a vacuum and establishing a pressure differential. Nitrogen admitted at the other end then flows through the tunnel simulating missile flight conditions of some twenty times the speed of sound and almost 60 miles altitude. Nitrogen is used rather than air to avoid having to remove moisture from the air prior to admission. In order to govern temperatures across the model, arrange-

ments are available with which to heat the nitrogen stream as it enters the tunnel and also again before it reaches the model. The tunnel is unique in that it requires only 50 hp to operate the refrigeration plant, whereas a comparable unit based on a gaseous diffusion pump would require 500,000 hp. The tunnel was built on a research contract for the Air Force Office of Scientific Research and the Office of Naval Research.

★ ★ ★

Nameless City On The Board With the opening of the Fall semester "far above Cayuga's waters," 30 Cornell University graduate students started planning what will be Colorado's second largest city. It will take form on the upper basin of the Colorado River where what is thought to be the world's largest source of oil is located. When the city reaches its full growth, it is expected to have a population of about 350,000. About a third of these people will be employed directly or indirectly with the oil industry. The petroleum that is the basic cause for this scientifically planned city is locked in shale that extends across Colorado, Wyoming and Utah, in the Green River Formation, and is estimated to amount to more than 1½ trillion barrels. With the rapid development of improved methods for extracting oil from the ground, it is thought that soon it will be economically feasible to tap this rich source. The students, all in the Department of City and Regional Planning, are working under the direction of Professor F. W. Edmondson and will complete their work in March 1959, at which time the plan will be presented to the Governor of Colorado. The work is being sponsored by the Shale Oil Development Committee of the Colorado State Chamber of Commerce. For the Cornellians, it is the second such city to be planned recently; last year they completed work on the new capital of Brazil, to be built in the interior.

★ ★ ★

75 Years To The Orient Whether a movie-goer or a railroad enthusiast, the name of the Orient-Express means one of the continent's most famous trains. This year marks its diamond anniversary. In 1883, the rail service connected Paris with the Balkans, only after seemingly insurmountable difficulties were overcome. Problems of varying rail gauges, signal systems and equipment had to be solved as the line passed from country to country. The first passengers on the Orient-Express traveled from Paris to the Danube River on rail, where they disembarked at Giurgio and caught a steam-driven ferry. Once across, a

second train with a different gauge, picked them up and carried them on to Varna on the coast of the Black Sea. Again boarding a steamer, they were delivered to Istanbul (Constantinople) some 15 hours later. Since then, the various railroad lines have been improved, so that now the Orient-Express makes a quick and efficient journey between the two terminals. After the First World War, two other lines were established: the Arlberg-Orient Express and the Simpson-Orient Express which passed through the northern portion of Italy.

★ ★ ★

Largest Galvanizing Kettle

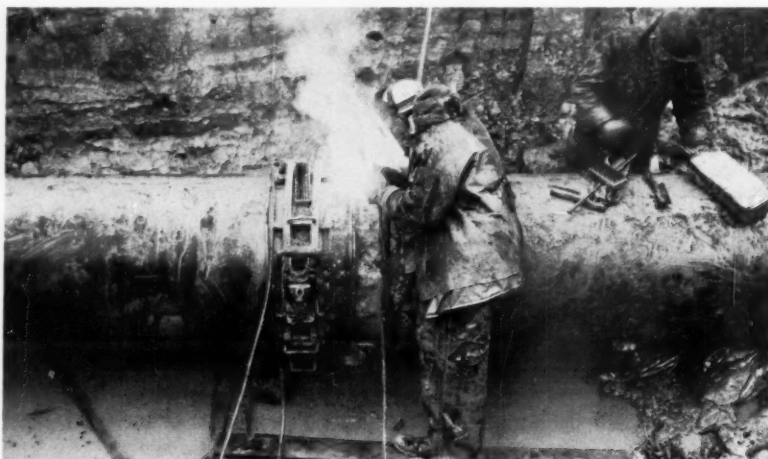
The world's largest galvanized kettle has recently been built by Lukens Steel Company's Lukens Division for Valcon Galvanizing, Inc., of Natrona, Pa. Measuring 40 feet 2 inches long, 51 inches wide and 6 feet 10 inches deep, the kettle exceeds by more than 3 feet the longest galvanizing unit now in operation. With this new facility, Valcon will process literally anything that can be galvanized. By providing 40 feet of head room, the company is now able to bring even the biggest steel members straight up out of the kettle, enabling them to be drained over the greatest length to give the smoothest possible zinc finish. Scheduled for processing,

as soon as installation is completed, are large steel trusses, pipe and plates, as well as oil derricks, tanks, grating, chains, bars, expanded metal, structurals and other steel items.

★ ★ ★

"New" Device First Built 800 Years Ago

A sound-absorption device, or more properly, an echo deadener, designed on the most modern principles and being exceptionally efficient, has come to light during the restoration of the Akebaeck medieval church in the Baltic island of Gotland. It is believed to have been installed at the time of building in the twelfth century. An instructor in the subject of building acoustics at the Royal Institute of Technology, Stockholm, Ove Brandt, made this discovery. He observed three round holes in the top of the ceiling of the dome, which, when inspected, proved to be the openings of clay jars mounted above them. A method believed to be new in the 1930's made use of a similar contrivance based on careful mathematical calculations. It was found that the twelfth-century jars had the form, proportions and tonal character of their modern counterparts. Brandt terms the discovery "a sensation of international scope." He believes it likely that other Gotland churches from the period may be found to be similarly equipped.



THE LAST WELD

Trans-Canada Pipe Lines Limited has completed final testing of its natural gas line from Alberta, to Montreal, Que., and approval from the Board of Transport Commissioners for Canada has been received. This marks the completion of a 2294-mile-long pipeline construction job that is the longest natural gas line in the world. Work began in July 1956 near Burstall on the Alberta-Saskatchewan border; and by the winter of 1957, natural gas was being used in homes and industries as far east as Port Arthur, Ont. The Toronto-Montreal section was also completed in late 1957 and placed in service with an interim supply of gas. During this last construction season, 5000 men built the final 852 miles, working east from Port Arthur on the Northern Ontario Pipe Line Crown Corporation section, and north from Toronto on the Trans-Canada section. The final weld, as illustrated here, was made near Kapuskasing where the two sections met, completing the \$375 million project.

Van Drebel's Northwest Passage



STUDENTS of naval and mechanical arts history are familiar with the name of Cornelius Van Drebel; most people are familiar with the dream of a Northwest Passage from the Atlantic Ocean to the Pacific.

Such a passage has long been frustrated by some 2,000,000 square miles of ice covering the major portion of the Arctic Ocean. On August 5 of this year an epic voyage by a nuclear-powered submarine, the *Nautilus*, was completed under the polar ice cap, thus linking inventor Van Drebel to a list of explorers including Henry Hudson, Sir William Edward Parry and a number of others.

It is doubtful that Van Drebel, in England, had even the remotest inkling either of the future development of the vessel whose prototype he built in 1620 or of the geography of the North. His submarine, said to have been navigated at a depth of from 12 to 15 feet below the surface of the Thames River for a period of several hours, was developed at about the same time that Hudson was making his famed explorations in search of a passage to the Indies by sailing either to the northeast or to the northwest. It was to be 200 years before Parry made his three attempts to traverse the Arctic by ship, on one of which he succeeded in sailing more than half of the distance between Greenland and the Bering Strait. The latter, incidentally, was not discovered by Vitus Bering until 1728. Van Drebel was several hundred years ahead of his time, however, and almost all of the details about his invention sank into obscurity.

SUBMARINES were first utilized as a war machine in 1776 when David Bushnell made his abortive attempt to utilize the *Turtle* to anchor a mine to a copper-bottomed English man-of-war anchored off New York. The submarine worked well, but the screw device for affixing the mine did not. Submersibles then lapsed into disuse until the American Civil War, when the *Housatonic* achieved the dubious distinction of becoming the first vessel to be sunk by a submarine. The submarine was also lost; however, progress continued. In both France and the United States, experiments were numerous and such men as Simon Lake, Max Laubeuf and John Holland became associated with the scheme.

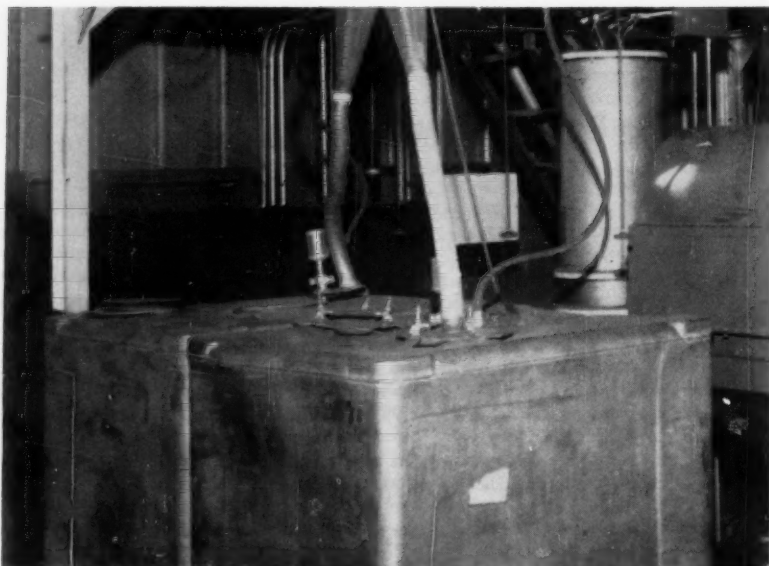
FULLY-COMMISSIONED submersibles were added to the U. S. Navy fleet in 1900 when the *Holland* was purchased and orders placed for five more vessels of her class. In 1915, a 150-foot-long, 15-foot-beam vessel was commissioned by the U. S. Navy and christened *Nautilus*.

Capable of a submerged speed of 10.5 knots, she served 7 years before being decommissioned. In 1928, Sir Hubert Wilkins led an expedition to the North Polar regions in a submarine also named the *Nautilus*—a forecast of things to come. Wilkins' vessel was originally the U. S. Navy's O-12 and was sold to the expedition with the proviso that it would be scrapped at the conclusion of the voyage.

Another *Nautilus*, commissioned in 1930, was one of the three largest conventionally powered submersibles in the U. S. fleet. She was 371 feet in length and had a submerged speed of 9 knots. After a distinguished record in World War II, she was taken out of service in 1945. The launching of the atomic-powered *Nautilus* in January 1954 marked not only a new era in naval annals but also the launching of the sixth such vessel to carry the name. The first was one built by Robert Fulton for Napoleon Bonaparte. The ship was successful, but Bonaparte lost patience with Fulton's experiments and dismissed him. The second was Jules Verne's famed fictional craft which in dimension and design constituted an uncanny prophecy of events in 1954.

NAUTILUSES are distinctive marine creatures resembling snails both in appearance and speed. Found principally in the South Pacific, the little shellfish live a very sedentary life, reclining on the bottom during the day and rising to the surface at night. Whether this elevator-like existence had much bearing on the selection of the family name for the distinguished undersea craft is questionable, but the Nautiluses of man have been pioneers in every sense. With the advent of the polar passages of the *Nautilus* and her sister ship *Skate*, mariners have envisioned whole new vistas of sea travel. From London to Tokyo is only 6300 miles via the Pole whereas it is 11,200 miles through Panama. Although the benefits of such a short cut are not expected to be realized at any early date by commercial vessels, some interest has already been stimulated in undersea bulk-cargo carriers that would be unaffected by surface weather conditions.

Regardless of the future course of submersible development, or of the Nautiluses that may one day replace the present one, it is sure that compressed air will be present. Anytime that man moves out of his own domain he has to carry along at least enough air to maintain life. Further, on submarines, compressed air is utilized to empty the ballast tanks, operate various equipment and expel torpedos. In many ways, the development of modern submarines has paralleled the development of high-pressure air-compressing equipment.



These Sealed Bins, Plus Pneumatic Handling, Equal—

\$20,000 ANNUAL SAVINGS

L IQUID-OXYGEN containers of 3000-cubic-foot capacity are built by the Linde Company at its Speedway, Ind., plant. Of sandwich construction, having an inner lining of stainless steel and an outer one of alloy separated by a lightweight insulating powder, the units maintain temperatures of about minus 300°F. The insulating powder used is highly hygroscopic and difficulties were

experienced in handling and transporting the substance. A bulk handling method, utilizing hermetically sealed, 74-cubic-foot capacity bins and a vacuum loading and unloading system is expected to save the firm about \$20,000 annually.

The bins, designed and fabricated by Tote System, Inc., Beatrice, Neb., have been used at the Speedway facilities since the end of 1957. They were in-

stalled there after a year's trial period at Linde's Tonawanda, N. J., plant that ships the insulating powder to Speedway. Made of aluminum, the Tote Bins, as they are called, have bases that enable the use of fork lifts in transfer operations. In use, the powder is placed in, and withdrawn from, the bins by a vacuum process. To further guard against product deterioration, Linde fills each container with an inert gas along with the insulating powder.

A total of fourteen bins are used in company operations, four of which are in shuttle service between New York and Indiana, and ten of which are in the Speedway plant for production and storage purposes.

Savings are calculated from such items as previous container expense, material loss and diminished labor costs. For example, the insulation formerly was received in 25-pound bags of polyethylene-coated, vapor-sealed tar paper. Each cost \$0.70. One Tote Bin handles the equivalent of 28 such bags, and normal operations call for the use of about one bin of material per day. A savings of \$19.60 per day is thus realized in disposable containers, or a total of more than \$5000 per year. By former methods, four men were needed to load and unload the bags—two for each operation. Now, only one man is needed for each step. The savings in reduced labor total about \$10,000 per year. When bags were used, any breaks or weather permeation of them resulted in complete loss of the material. Adding these savings to the container and labor savings results in the estimated \$20,000 annual cost reduction.

MOLES WILL HONOR ARMSTRONG, BONNY



ARMSTRONG

THE well-known Moles Awards are to be presented for the nineteenth time January 28. The member honoree, according to an announcement by Howard A. Collins, president, is to be James F. Armstrong, vice president of Peter F. Connolly Company. In heavy construction work for more than a half century, Armstrong did a great deal of work in the field of pneumatic caissons for bridge foundations. He was also associated with the Arthur McMullen Co., Senior & Palmer, Inc., and the Walsh Construction Company.

John Bruce Bonny, the nonmember recipient, is vice president and general manager of Morrison-Knudsen Company, Inc., having been with that concern since 1931. A University of California graduate, Bonny flies more than 200,000 miles per year visiting far-flung M-K jobs. During 1958, the firm had more than twenty separate contracts in progress in the United States and eighteen more in foreign nations.



BONNY

Programmed Maintenance In A Supermarket

PLANNED preventive maintenance of equipment, whereby small defects are caught and repaired before they become major, costly ones, is a basic concept of modern industry. It is applicable in other endeavors, too. A large New England supermarket chain benefited when it instituted such a plan for its many thousands of roller-mounted grocery carts; and the use of air tools greatly helped the firm carry out its revised system.

The company's old method for taking care of the carts depended upon individual store managers sending the carriages for repair when needed. It was a "hit-or-miss" procedure because the store managers were generally too busy to keep a close check on the carriages. The results were inevitable: many poor carts were in service. They were dirty; their wire frames were rickety; and, of course, many were running on noisy and bothersome "square wheels" that make marketing unpleasant. Even worse, these faults drew customer complaints. Being in such a run-down condition, the carriages often had to be replaced, even though they were relatively new.

Although the grocery company did have a central repair point to receive faulty carts, no scheduling was in effect. Sometimes there would be a flood of carriages and some would have to be sent to outside contractors in order to get them back into service within a reasonable time. Repairing consisted of steam cleaning, straightening the struc-

tural members, replacing or straightening the wire baskets, replacing wheels and castors, and painting. The baskets were brush painted with aluminum paint, and the structural supports were painted green. Normally, the baskets remained on the frames; and a good paint job was impossible because the baskets nestled in the frames of the carriages.

The store finally decided to establish a new, regular reconditioning plan that would provide servicing of each carriage once every 6 months. Because this reconditioning station serviced approximately 600 stores in the New England area, about 20,000 carts had to be cared for. This meant 160 carriages had to be handled every day, as compared with the old figure of 25 per day. Six air tools were put to work to make the maintenance faster and more efficient. Two Ingersoll-Rand Size MC-12 Impact Cutter Kits are used to shear and punch out two 1/4-inch brazier head rivets that anchor clamps that secure the cart basket to the frame. These cutters are also used for such special jobs as removing rust, scale and sticky foreign matter that steam cleaning will not touch. A second pair of air tools, two I-R Size AR-130 Air Buck riveters, put new rivets in the securing clamps after the basket and its frame have been painted.

Two Ingersoll-Rand Size 502 Impacttools run nuts on the wheels and castors. Machine bolts and nuts of 1/4-inch diameter hold the rear wheels to the frame,

and the front wheels are fastened in the same manner to castors. The castors are attached to the frame by a 3/8-inch threaded stud. All are run with the Impacttools. Other new equipment put into service includes a 5-hp compressor, a larger steam cleaning unit, and a spray gun and booth to replace the previously used brush method.

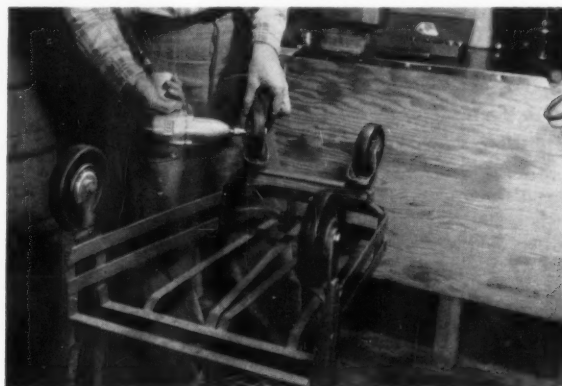
The advantages of the air tools and a planned maintenance procedure are evident in the figures relative to the work. Reconditioning for each cart formerly required 0.64 man-hours, while, with the new plan, it takes only 0.30 man-hours. Six men are required to efficiently operate the new maintenance system instead of the former two. However, this expense is more than offset by the faster and more thorough work done per carriage, the resulting increase in overall cart life, and the elimination of the high cost of outside contract work.

Working under the old system, two men managed to recondition their 25 carriages each day at an expense of \$0.96 per cart, based at wages of \$1.50 per hour and an 8-hour day. With the new system, six men, with their 160-cart-per-day output, rebuild carriages for only \$0.45 each, based on the same labor and work-day figures. This means a savings per carriage of \$0.51 and, in addition, the rebuilding job is better than that previously obtained. Of inestimable added value is the fact that customer complaints about dilapidated carriages have been eliminated.



CARRIAGE REASSEMBLY

After they have been painted, the basket and frame are joined by a clamp that is riveted together. Here, an Ingersoll-Rand AR-130 Air Buck riveter is seen driving the 1/4-inch fasteners. A brazier head yoke and a Jackset are being used with the riveter.



IMPACTOOL REPAIRS WHEELS

This I-R Size 502 Impacttool is running a 1/4-inch machine bolt that forms the axle for the grocery cart wheel. Replacement and repair of wheels and castors eliminate the noisy and hard-to-manage "square wheels" that are found on worn carriages.

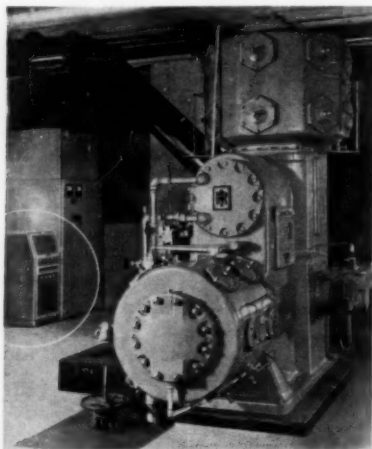
Industrial Notes

CONDENSER tube protectors of fracture-proof nylon are designed to prevent turbulence in condenser water flow. The protector's inner wall gradually tapers toward the discharge end, providing an extremely thin section at that point. Thus, it is said, the close conformity of the protector end with the inner diameter of the tube allows unrestricted passage. Nylon's high resistance to sand blasting, air impingement, corrosion, fungus, alkalis and solvents is also an advantage. The tube protectors are currently available in $\frac{3}{4}$ -inch, 16 and 18 BWG; $\frac{7}{8}$ -inch, 16 and 18 BWG; and 1-inch, 18 BWG sizes. *Crane Packing Company, 6400 Oakton Street, Morton Grove, Ill. In Canada: 617 Parkdale Avenue, N., Hamilton, Ont.*

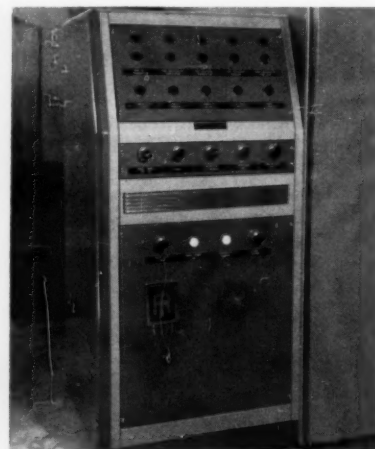
UNITRACE is the name of an extruded aluminum pipe with an integral steam passage that was introduced by Alcoa in 1953 in sizes of 1, 1½, 2, 3 and 4 inches. Now, the facility is supplying 6- and 8-inch sizes to meet the



demands of economically moving large volumes of such bulk substances as urea, fuel oil, asphalt and similar materials that must be moved by steam-traced piping. The steam-heated piping reportedly retains its efficient heat transfer, low cost, ease of installation and unusual corrosion resistance. *Aluminum Company of America, Public Relations Department, 1501 Alcoa Building, Pittsburgh 19, Pa.*



TENDAMATIC, an automatic compressor control system developed by Ingersoll-Rand Company, continuously supervises and checks compressor operations and gives warnings if any malfunction occurs. After the start button on the console is pressed, the system takes charge, monitoring the compressor's every operation. Pressures and temperatures of the air and lubricating oil, cylinder lubrication operations, float level in the condensate trap, leaking valves and mechanical failure of running parts are all checked. If any abnormal operation should occur, the unit's horn sounds and an amber light goes on to identify the trouble. If no cor-

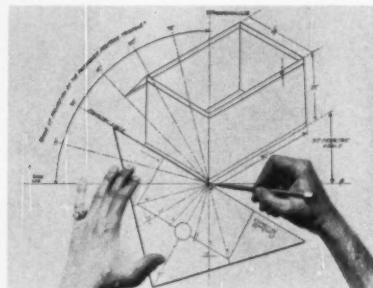


rective action is taken, the system will automatically stop the compressor before damage can occur. If oil pressure fails or vibration develops, the compressor is stopped without a warning period. The system is designed to eliminate routine inspection for any manufacturing or mining operation, and only preventive maintenance is said to be required. The unit is available only on I-R compressors; it can be supplied for machines ranging in size from 100 to 4000 hp. The photograph reproduced above shows the Tendamatic used with an Ingersoll-Rand 2-stage heavy-duty XLE compressor. The picture at the right is a close-up of the console. *Ingersoll-Rand Company, 11 Broadway, New York 4, N. Y.*

SMOOTH and dependable stops of heavy industrial equipment are reportedly possible with two air braking systems, both available with 14x6- or 18x8-inch external-type shoes. One system, built for service stops and parking, and holding operations, utilizes both an air-actuating cylinder and a spring-applied, air-released parking cylinder. The other brake, for service stops only, uses the air actuating cylinder that includes a return spring for quick release. With the exception of the cylinders, all parts of the units are said to be interchangeable with the manufacturer's hydraulic brakes of like size, providing simplicity of service and parts inventory. *Wagner Electric Corporation, 6400 Plymouth Avenue, Saint Louis 14, Mo.*

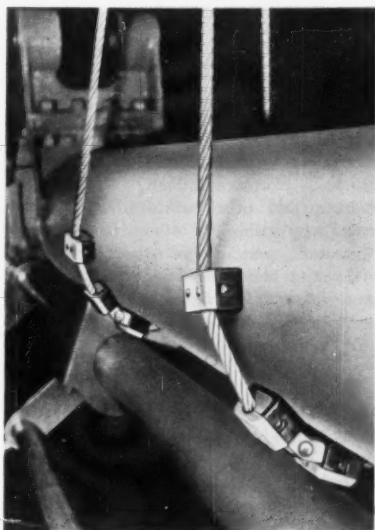
HEAVY-DUTY sanitary hose is manufactured for use in creameries and dairies, as well as food preparation and meat packing plants. Flexsteel Sanitary features a braid of high-tensile steel wire and two cotton braids. Its cover is reportedly highly resistant to animal and vegetable fats, oils, weathering and abrasion. The hose is offered in 25- and 50-foot lengths with inside diameters of ½- to 1½-inch size. It is built to withstand saturated steam pressures up to 100 psig. *Goodyear Tire & Rubber Company, Akron 16, Ohio.*

TO REDUCE board time in both engineering departments and in the field, a Pacemaker drafting triangle is offered that combines the functions of a drafting machine, and eliminates the use of T-squares and former drafting aids. It is said that complete drawings are constructed with this single device. On its



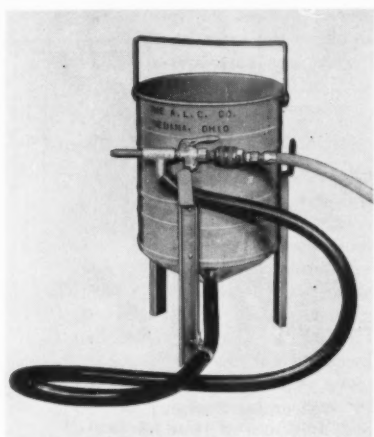
14-inch hypotenuse, all baselines, common angles, isometric projections, perpendiculars, bisections and parallels are projected instantly and accurately with a single stroke. *Pacemaker Drafting Supply Company, 2828 Hudson Boulevard, Jersey City, N. J.*

PADS of aluminum alloy faced with nonscuffing rubber protect equipment that is crane-lifted in wire rope slings. Known as Sela pads, these patented protectors are mounted directly on the wire



rope and are slipped by hand to points where damage of the load may occur. The elimination of repainting or repolishing, that moving damage may make necessary, reportedly saves both time and money. The pads are fabricated in five sizes that enable them to be used on steel wire ropes from $1\frac{5}{32}$ to $1\frac{3}{4}$ inch in diameter. Two models are available: Sela standard for use on straight surfaces; and Sela angles for use on sharp edges. *Columbia Technical Corporation, 61-02 Thirty-first Avenue, Woodside 77, N. Y.*

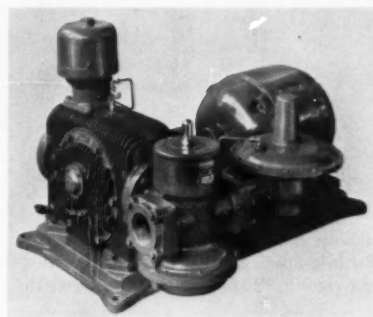
FOR BLASTING operations where no blast room is available, Sandy Jet Spot Blaster has been developed. Reportedly it quickly and easily cleans rust, paint, carbon, dirt and weld scale from mold-



ings, seams, corners, and engine parts. The unit operates on an air pressure of 100-185 psig, and a cardboard placed over the top is all that is needed to keep the abrasive confined. The tank holds 12 quarts of abrasives, such as low-cost silica sand, metal shot, nut shells and aluminum oxides. For cleaning engines and parts, liquid detergents may be used in this low-cost device. *A. L. C. Company, 646 Oak Street, Medina, Ohio.*

ACCURATE mixtures of propane and air, or butane and air, are said to be automatically provided by a Propane Diluter. Applications include maintaining of heat processing operations, space heating, water heating, cooking or refrigeration during periods of fuel cut off. The instrument can be connected to existing gas piping and eliminates the need for expensive dual piping, separate air blowers, inspirators, mixers and the like. Simplified interchangeability is achieved without having to adjust appliances or gas burners. A balanced-pressure, full-floating mixing valve has precision-machined metering ports. The valve is adjusted by a vernier worm-wheel mechanism for control of gas-air ratio, reportedly through a range of 50 to 1. Other advantages include delivery of mixtures sufficiently high to produce

the same heating rates as normally attained before fuel cut off; maintenance of constant pressures even when load

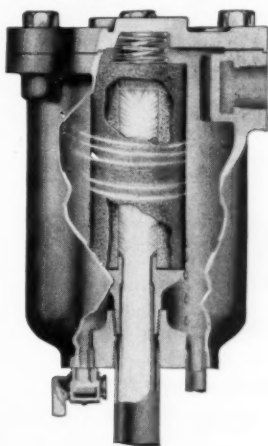


variations are extreme; and maximum flame speed and combustion efficiency. *Selas Corporation of America, Dresher, Pa.*

ONE-THIRD the size and weight of most $\frac{3}{8}$ -inch valves is said to be an advantage of a 4-way Dual-Seal solenoid valve. The device reportedly operates at speeds that meet any known requirements and tests at higher than 40 million cycles. It has eleven parts, only two of which move. Available in $\frac{1}{4}$ -, $\frac{3}{8}$ - and $\frac{1}{2}$ -inch port sizes, the device's solenoid and cover may be detached quickly

ADAMS PORO-STONE AIR FILTER

designed to remove oil, water and foreign matter from compressed air lines with minimum pressure drop.

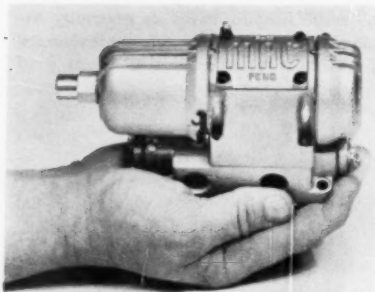


The R. P. Adams Poro-Stone air filter is engineered to efficiently remove entrained oil, water and pipe scale from compressed air lines. Liquid

droplets and solids being carried by the gas stream are first removed by centrifugal action in an annular chamber. Secondary filtration is achieved by passing the air or gas stream through a Poro-stone unit. An automatic trap can be provided to discharge the residue from the cyclone chamber.

At rated capacity the filters operate at a maximum pressure drop of only $\frac{1}{2}$ lb., thus insuring delivery of line pressure to the point of consumption. The units require virtually no service or maintenance — thereby insuring continued trouble-free, low cost performance.

ADAMS Poro-Stone air filters are available from stock in sizes to suit your needs. For further information, write today for Bulletin 117, R. P. Adams Co., Inc., 209 East Park Drive, Buffalo 17, New York.

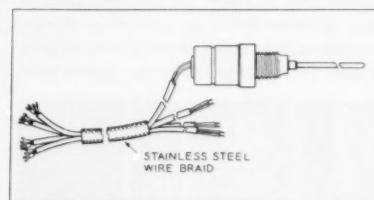


without tools. The valve uses a spool-within-a-spool design. It has standardized manifold bases that permit the

grouping of two to ten of the units to form a single inlet, single exhaust and single conduit channel. Integral conduit boxes and plug type wire lead connectors are included. *Mechanical Air Controls, Inc.*, 10030 Capital, Oak Park, Detroit 37, Mich.

TEMPERATURES to 2000°F at pressures to 50,000 psig are measured by a metal-sheathed, ceramic-insulated thermocouple called Armorox. The flexible unit can be bent around twice its own diameter to take readings at hard-to-reach locations. Sheathing can be either stainless steel or Inconel and is

obtainable in diameters from 1/16 to 1/4 inch and lengths to 30 feet. Wire as



mild as No. 30 AWG can be used. The thermocouples, available in Chromel-Alumel, iron-constantan, copper-constantan and other materials, are said to be applicable for every use of conventional pencil-type thermocouples. The units meet the ISA standards for accuracy. *The Bristol Company*, Waterbury 20, Conn.

NEW SILENCER for air exhausts



High noise levels are effectively reduced by a new silencer developed by Air-Maze Corporation. Fits directly to exhaust ports or piping. Breaks up shock waves to attenuate objectionable noise without noticeably impairing efficiency

of air operated equipment.

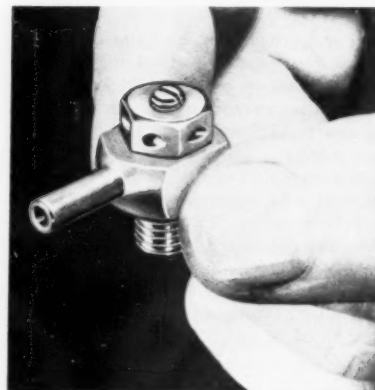
Standard sizes for 1/8"-1/4"-3/8"-1/2"-3/4" pipe sizes.

Write for details in Bulletin KK-657, **THE AIR-MAZE CORPORATION**, Cleveland 28, Ohio. Department CA-12.

AIR-MAZE

The Filter Engineers

AIR FILTERS • SILENCERS • SPARK ARRESTERS • LIQUID FILTERS
OIL SEPARATORS • GREASE FILTERS



ing operations in closely confined working areas. Reportedly, the devices are easy to install and operate, and are trouble-free, in a temperature range of minus

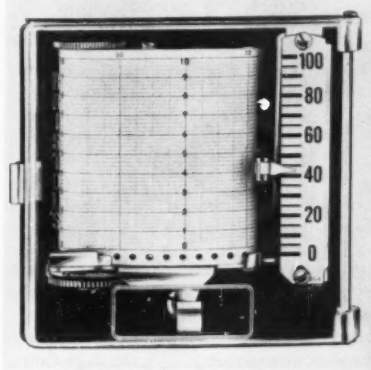


"Meet Joe Burke, Bob. He's taking over your job here."

65° to 250°F. Flammable, toxic and corrosive materials can be bled safely with these devices. They have operating and burst pressures of 3500 and 14,000 psig, respectively. A plastic or rubber tube may be slipped over the discharge nozzle to completely eliminate splatter and mess. A clear plastic tube may be used to visually check completion of purging. *Fluid Regulators Inc.*, 313 Gillette Street, Painesville, Ohio.

BLOWGUNS called Saf-T-Air operate from a shop air line and are used to blow chips and dirt away from work surfaces. Model 1B, as an example, is designed for overhead suspension or for use in confined areas. It incorporates a design by which it is said that about 40 percent of the air stream forms a protective, funnel-shaped screen that shields the operator from flyback, thus giving him complete protection. *E. V. Nielsen, Inc.*, 575 Hope Street, Stamford, Conn.

RECORDING pressure gauges that utilize 3-inch strip charts are available in models that record pressures in ranges from 0-3 to 0-60 psig. The recording chassis is interchangeable and can be plugged into its panel, it is said, without



the use of tools. Either pneumatic or electric drives can be used. Several varieties of the instrument are available for simultaneous recording and indicating of multiple pressures. *The Bristol Company*, Waterbury 20, Conn.

ACCURATE control of an air stream is achieved with an aluminum air blow gun that is contoured to fit the operator's hand, providing a natural and comfortable grip. The trigger eliminates awkwardness in releasing or directing the air stream and reportedly does away with hand and finger fatigue. The trigger uses a cam to operate the balanced piston valve, allowing the finger pressure to remain the same regardless of pressure and flow being used. The valve

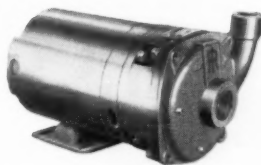
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THERE'S A REASON why more and more Motorpumps are being specified today in all types of industry:

Only the Ingersoll-Rand Motorpump combines proven features with modern design engineering that provide rugged dependability, highest pumping efficiency. Motorpumps give you ease of installation, low cost operation and minimum maintenance.

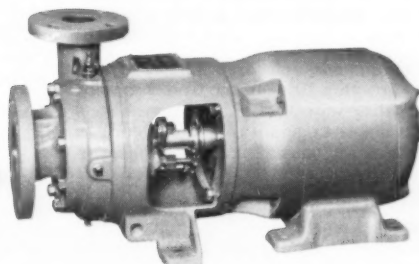
To meet your particular requirements, Motorpumps are available in the widest range of sizes and types. Capacities go from 5 to 2800 gallons per minute; heads to 650 feet. Write today for the latest bulletin.



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NON-FLUID OIL is best in performance for pneumatic tools regardless of air moisture content. Special "NR" Grades of NON-FLUID OIL by emulsifying with moisture trouble free lubrication, while automatically protecting against rust and sticking. Manufacturers of air tools recommend "NR" Grades of NON-FLUID OIL and leading engineers and contractors always specify it. Equipment operates faster and tool maintenance costs are kept down.

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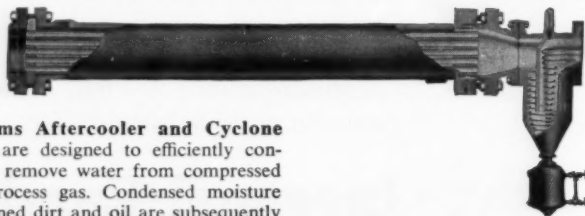
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Atlanta, Ga. Charlotte, N.C. Chicago, Ill. Greensboro, N.C. Providence, R.I.
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Aftercooler and Cyclone Separator designed for cleaner, dryer compressed air

R. P. ADAMS CO., INC.

209 East Park Drive, Buffalo 17, New York



The Adams Aftercooler and Cyclone Separator are designed to efficiently condense and remove water from compressed air and process gas. Condensed moisture and entrained dirt and oil are subsequently removed in a cyclone type separator. This unit is scientifically designed for maximum removal efficiency over a wide range of flow rates.

For normal use, units are available to cool gases to within 10° F of the temperature of the cooling water. Specially designed units are available to permit a 2° F approach to cooling water temperature, for application where low moisture content is critical.

Adams Aftercoolers and Separators are available from stock to handle 20 - 40,000 cfm with 10° cooling and 25 - 19,200 cfm

where it is necessary to cool within 2° F of the cooling water. Special units can be supplied to suit an unlimited range of requirements. In all cases the maximum pressure loss at rated capacities is ½ psi.

This wide range of sizes enables the economical utilization of Adams Aftercoolers and Separators in virtually all industrial application. For further information on how R. P. Adams' units will solve your compressed air problems and save you money, write today for Bulletin 711.

is a simple mechanism with a Teflon seal that can be easily and economically replaced. The gun's long straight orifice permits the operator to maintain complete control of directing the air stream. A hooked trigger guard serves as a finger safety guard and as a hanging device. Extension nozzles, 10 inches long, are available in both straight and curved end design. Perfecting Service Company, 332 Atando Avenue, Charlotte, N. C.

MINERS and riggers will be interested in Sauerman Duro-lite blocks made of high alloy steel, but now equipped with shrouded housings to assure proper seating of the running rope. They help prevent the rope from binding at the throat of the block, thus reducing break-



age and cable wear. The shrouds are especially recommended where blocks must operate in a horizontal plane—where the rope has a tendency to leave the sheave grooves. Sauerman Bros., Inc., 648 South Twenty-eighth Avenue, Bellwood, Ill.



"And remember, if you want to be successful in this business you must keep on your toes."

**Industrial Books,
Films and Literature**

TWO VOLUMES of a 3-volume work, *Aircraft and Missile Propulsion*, have been published. Their author is Dr. Maurice J. Zucrow, professor of gas turbines and jet propulsion at Purdue University, who was prompted to write the books because of the current rapid development of engines for guided and unguided winged aircraft and missiles. Volume I, subtitled *Thermodynamics of Fluid Flow and Applications to Propulsion Engines*, discusses the principles of technology involved. Chapter headings include: Review of Fundamental Principles, General Characteristics of Propulsion Systems, Thermodynamics of Compressible Fluid Flow, Flow Through Nozzles, and Flow Through Diffusers. In Volume II, subtitled *The Gas Turbine Power Plant, The Turboprop, Turbojet, Ramjet, and Rocket Engines*, the cycles and performance characteristics of these engines are analyzed, one chapter being devoted to each engine. Volume III, now in preparation, will deal with components of the engines. Volume I contains 538 pages; cost, \$11.50. Volume II has 639 pages; cost, \$13.00. John Wiley & Sons, Inc., 440 Fourth Avenue, New York 16, N. Y.

WATER in industry, and its importance to national well-being, are discussed in a booklet, *Your Most Important Raw Material*, by Everett P. Partridge. The paper was presented as the Edgar Marburg Lecture at the 1957 annual meeting of the American Society For Testing Materials. The publication points out that a plentiful supply of water exists but that it is not as well distributed as would be desirable. Stressed is the fact that the great problem is the control of water pollution by both domestic and industrial wastes so that repeated reuse will be possible with over-all economy. Twenty-five references are cited in the 27-page booklet. Cost, \$1.25. American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa.

ADVANCED students in metals technology may be interested in *Powder Metallurgy in Nuclear Engineering* as a reference book. The 275-page illustrated volume was assembled under direction of Dr. Henry H. Hausner, consultant to Sylvania-Corning Nuclear Corporation. Most of the work and findings described were conducted under U. S. Atomic Energy Commission sponsorship. Fifteen chapters range in content from general metallurgical problems in the design of nuclear reactors through safe handling of pyrophoric and radio-

NUGENT

offers something *Unique* in strainers



Figure 1554A-4L strainer basket available in brass, steel or stainless steel screen. 8 x 8 to 100 x 100 mesh.

Figure 1554-4L and Figure 1490DD-4L strainer shells are identical. Strainer baskets shown are interchangeable in this model.

Figure 1490CN-4L basket. Star-shape provides 20% more free screen area in this size. Available same metals, mesh as Fig. 1554A.

Nugent pipe line strainers can materially reduce your maintenance labor costs and hold down-time to a minimum. Unlike most strainers of this type, both the Nugent round basket and star-shaped extended area strainers, shown above, catch and hold their accumulation of foreign solids in the interior of the strainer basket.

Dirty liquid, under pressure, enters the strainer through the bottom inlet. It is then propelled upward through the center tube assembly. Emerging at the top, the liquid travels outward and downward, through the mesh of the basket and to the side outlet. In this manner, foreign solids are trapped *inside* the strainer basket which is then easily lifted from the outer shell for cleaning. A clean spare basket may be immediately substituted and the dirty basket cleaned when convenient.

Most other strainers direct the flow of dirty liquid from the exterior to the interior of the basket. Thus, foreign matter is trapped between the outer shell and the basket; not inside. When these dirty baskets are removed for cleaning, it is almost impossible to prevent some foreign matter from flowing back to the inlet and outlet piping. This type also requires scraping and cleaning the interior of the outer shell, a time consuming task that increases down-time.

Nugent strainers can save you time and money. For full details write for Bulletin 6.



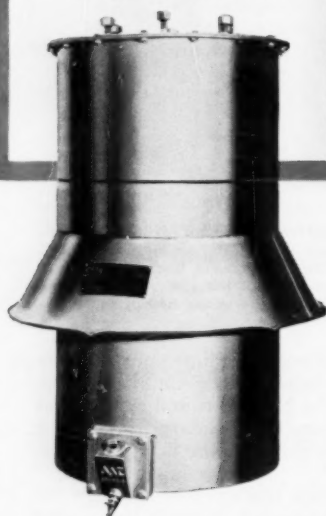
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AAF Type "W" Cycoils have proved themselves in thousands of installations—even where dust conditions were most severe. High collection efficiency and virtually maintenance-free operation have made Type "W" Cycoils favorites in all industries. The operation of the Cycoil is unique. A combination of oil impingement, centrifugal action, and filtration results in practically 100% dust removal in standard A.S.H.V.E. tests. Would you like more information? Write for our illustrated catalog.



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active metal powders. Powder metallurgy of zirconium, uranium, thorium, beryllium and various alloys are discussed, as are metal powders, preparation for reactors, ceramic fuel materials and related topics. There are 243 literature references and 100 charts, tables and graphs in the 6x9-inch book. Cost, \$8.50. *American Society for Metals*, 7301 Euclid Avenue, Cleveland 3, Ohio.

EXPANSION joint design, construction, application and testing are explained in a standard on the subject. Much of the information reportedly has never been published in any text or reference book. The 31-page booklet will be of value to manufacturers, contractors, engineers and government officials. A technical committee of ten members—engineers for several industrial firms—compiled the material. This first edition has 8½x11-inch pages and a semiflexible simulated leather cover. *Expansion Joint Standards*. Cost, \$1.00. *Expansion Joint Manufacturers Association*, 53 Park Place, New York 7, N. Y.

FIRE hazards involving flammable liquids, in areas such as hanger deck spaces of aircraft carriers, are reportedly controlled by an improved sprinkler head that is the subject of a Naval Research Laboratory report. According to the report, the sprinkler is a combination foam and water nozzle that delivers a pattern of foam when supplied with a 6-percent foam solution. Without the solution, it performs as a normal water sprinkler. The device is said to equal or surpass the cooling and structural protection ability of water sprinklers. It has the added advantage of being capable of rapidly extinguishing severe fires with a foam blanket that remains to prevent reflash. The system reportedly can be easily activated automatically, requiring no manpower during the

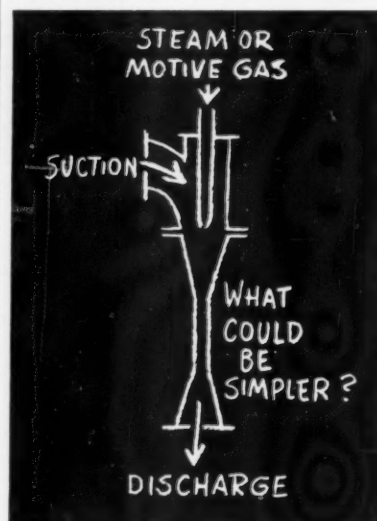


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GASES

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NO MOVING PARTS



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nothing moves
but the motive
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AS SIMPLE and sturdy as a piece of pipe, the I-R Ejector offers real economy and dependability for a wide range of applications.

They can be used to create vacuum or increase pressure, and to mix gases.

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extinguishing operation. The 45-page report about the sprinkler is designated PB 131740 and entitled, *A Study of the Characteristics of Foam-Water Sprinkler Systems in Controlling Full-Scale Fires*. Cost, \$1.25. Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C.

CORROSION on steel surfaces is the subject for a 16-mm sound film. The color movie tells what causes anodes and cathodes to form on steel surfaces, how they produce electrolytic corrosion, and what can be done about it. Protection in the form of inhibitors, hot-dip galvanizing, cathodic protection, metallizing, organic coating and Dimetecote inorganic zinc coating are discussed. Case histories shown in the 19-minute film explain how corrosion problems are solved in various industries, and ideas are presented for those interested in corrosion control. *Amercoat Corporation*, 4809 Firestone Boulevard, South Gate, Calif.

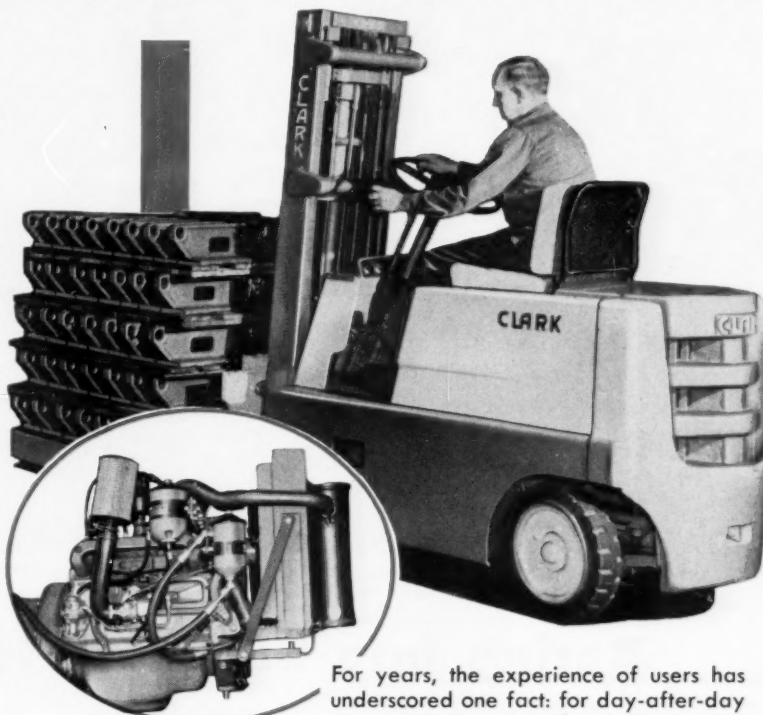
LAKE Maracaibo and the bustling oil industry at the large Venezuelan body of water are the subject for a color movie, *A Mile to El Dorado*. The title of the 27-minute film refers to the vertical mile to the rich petroleum deposits lying below the lake. El Dorado was a fabled city of gold, sought for centuries by Spanish explorers. The picture depicts the beauty of the Venezuelan countryside, and shows how oil production has helped the nation. Also shown are the special problems presented by offshore operations in the lake, and how technology is at work to solve them. Reynolds Metals Company produced the movie. The film, designated S-597, is available without charge from the nearest office of Association Films. *Association Films, Inc.*, Broad and Elm, Ridgefield, N. J.; 561 Hillgrove Avenue, LaGrange, Ill.; 1108 Jackson Street, Dallas 2, Tex., and 799 Stevenson Street, San Francisco 3, Calif.



Another Winning Combination

CLARKLIFT* 40 and

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**CONTINENTAL
F4162 Engine**

**DISPLACEMENT
162 cu. in.**

**HORSEPOWER
49 at governed
speed of 2,200 rpm.**

**MAXIMUM TORQUE
123 lb. ft.
Available also for use
on LP fuel**



*TM REG.

For years, the experience of users has underscored one fact: for day-after-day dependability, this Clark-Continental work team is mighty hard to beat. In the new Clarklift 40, as in numerous other Clark models that are gaining ever-wider acceptance in the industrial and construction fields, Clark Equipment and Continental Motors have joined hands, with outstanding results. Their engineering experience and manufacturing skill are producing specialized machines that speed the work and cut the cost on a steadily-lengthening list of jobs. And while they vary widely in size, in power, in purpose, these units have in common an amply-proved capacity to operate day in, day out, with a minimum of costly down-time.

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6218 CEDAR SPRINGS ROAD, DALLAS 9, TEXAS • 1252 OAKLEIGH DR., EAST POINT (ATLANTA) GA.



Bethlehem Hollow bites into hard basalt at site of powerhouse for Ice Harbor Dam, being built on Snake River, Washington, by U. S. Army Corps of Engineers, Walla Walla District. Contractor: Montag-Halvorsen-Austin & Associates. Drill steel furnished and reconditioned by Senter Tool Service.

Boring into basalt at Ice Harbor

Ice Harbor Dam, currently under construction, is the first of four dams planned for the Lower Snake River, in south-east Washington. Ultimately, this water-control system will extend slackwater navigation from the confluence of the Snake and Columbia Rivers, a distance of 150 miles, to Lewiston, Idaho. Ice Harbor Dam will be 2,790 ft long, and will control a 35-mile reservoir.

The project called for the removal of 780,000 cu yd of basalt, and the drilling phase was accomplished economically with Bethlehem Hollow Drill Steel. Blast holes ranged from 12 ft to 24 ft deep.

Bethlehem Hollow Drill Steel is ideal drill steel for economical rock drilling. It's tough, fatigue-resistant, long-lasting. Its uniformly round hole is centered in the bar. It has a wide quenching range. Moreover, it is easy to heat-treat to attain the proper balance of toughness and wear-resistance, making possible strong threads and shanks.



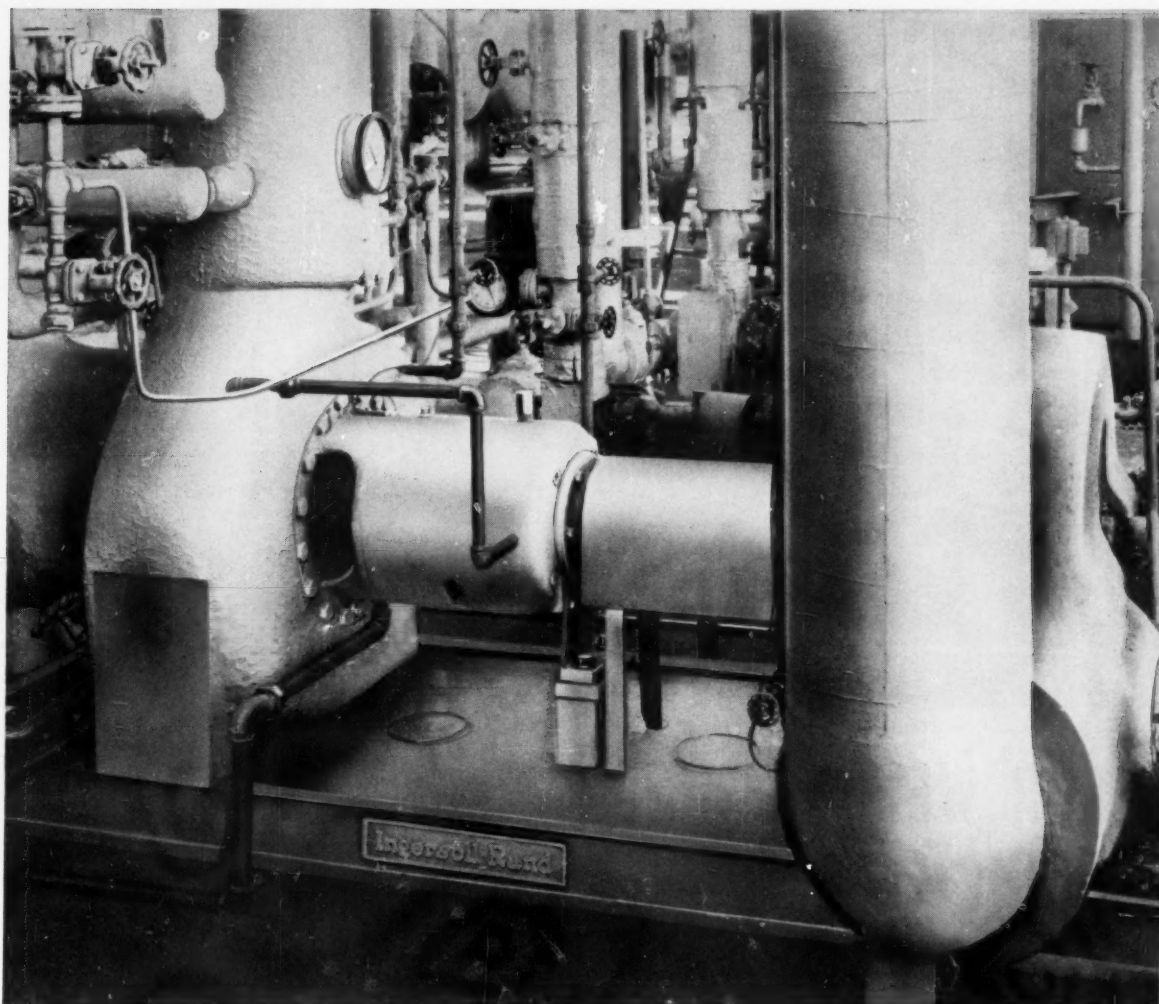
You'll do well to specify Bethlehem Hollow for every drilling job. It comes in Carbon and Ultra-Alloy grades in rounds, hexagons, and quarter-octagons, and in lengths from 18 ft to 27 ft, and longer.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. Export Distributor: Bethlehem Steel Export Corporation

BETHLEHEM STEEL





Chromium-Nickel stainless steel takes pump into its 4th non-stop year . . . circulates 246°F urea

There's no spare for this stainless steel pump. Yet it's essential to the process — recirculates 4600 gpm of corrosive urea-and-oil.

It needs no spare because Ingersoll-Rand makes casing and impeller of a specially developed chromium-nickel stainless steel . . . gives extended service in organic acids. The pump shaft is made of a similar stainless steel.

Now in its 4th year, the pump has never had a forced shutdown for maintenance. There's every sign it'll do its job for years to come.


Nickel-containing stainless steel muzzles corrosion's bite in many other processes.

For instance—a centrifugal rotor of cast ACI type CF-8M stainless shows no corrosion after 12 years' service in slurries of warm weak sulfuric and lactic acids. Or—a hopper of chromium-nickel stainless handles hot magnesium carbonate slurry without product discoloration or excessive down time. Basic toughness of the stainless in this hopper cuts down metal loss from abrasion.

Good workability, too.

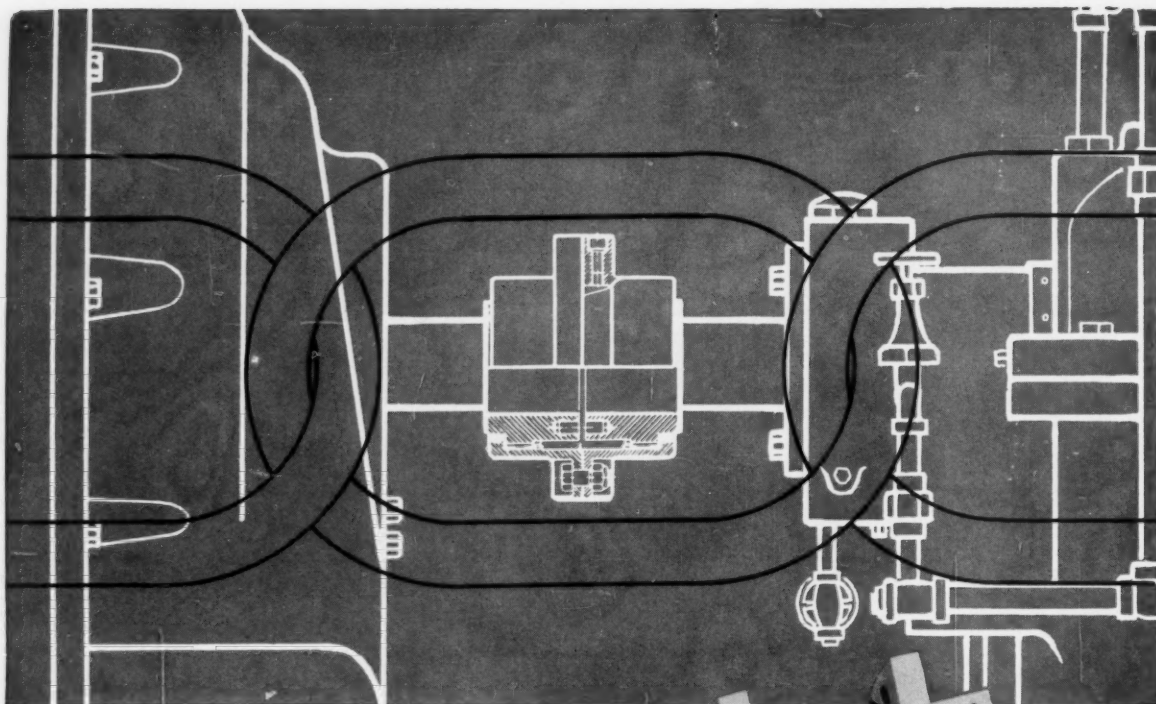
Austenitic stainless steels are readily formed by drawing, spinning, bending and shearing. Welding, soldering, hot forging and riveting are comparatively easy.

Where you find corrosion a threat, the austenitic stainless steels may well be the most practical materials you can use. Write Inco's Corrosion Engineering Section for advice on your specific corrosion problems.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street  New York 5, N. Y.

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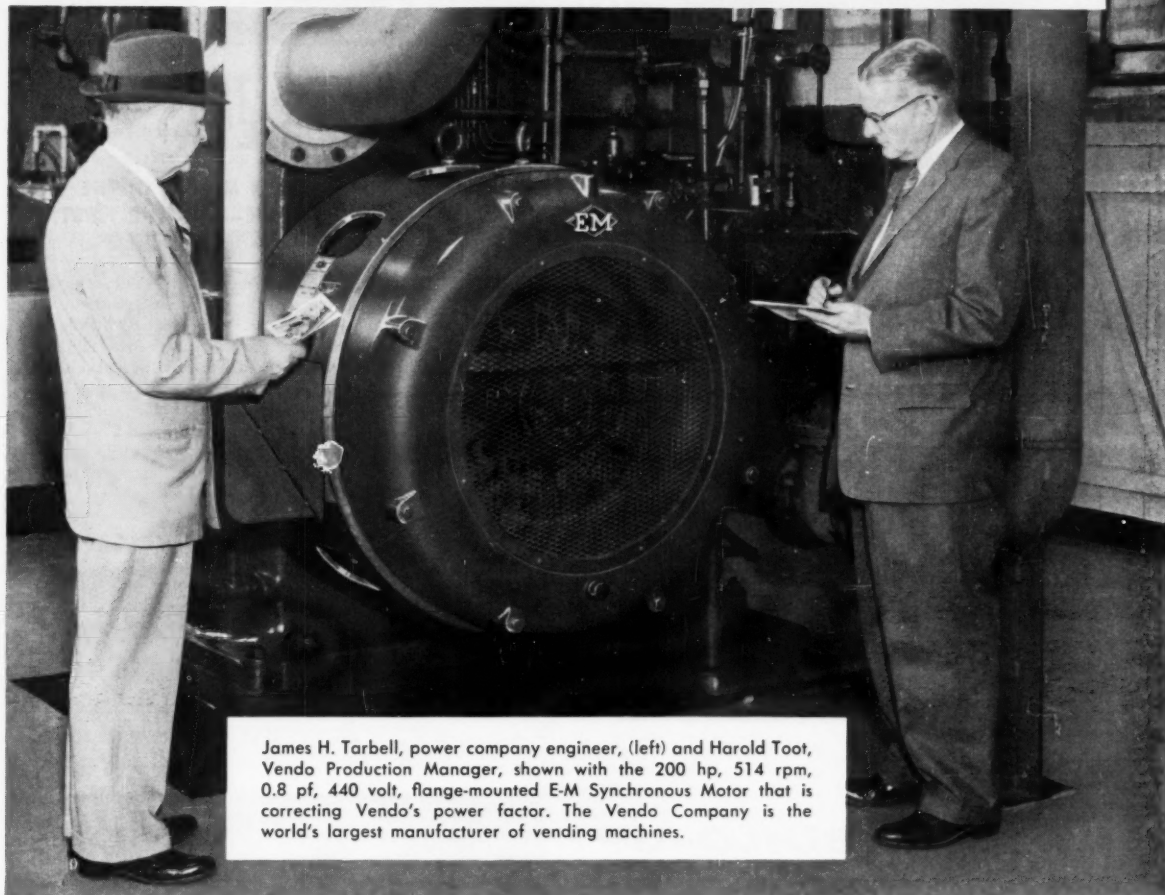
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Ask for Catalog 57

Are You Paying Big Penalties for Lagging Power Factor?



James H. Tarbell, power company engineer, (left) and Harold Toot, Vendo Production Manager, shown with the 200 hp, 514 rpm, 0.8 pf, 440 volt, flange-mounted E-M Synchronous Motor that is correcting Vendo's power factor. The Vendo Company is the world's largest manufacturer of vending machines.

Vendo Company Corrects Power Factor... SAVES \$450 A YEAR! with an E-M Synchronous Motor

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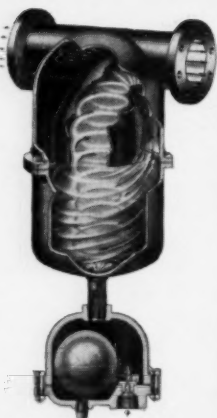
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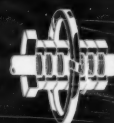


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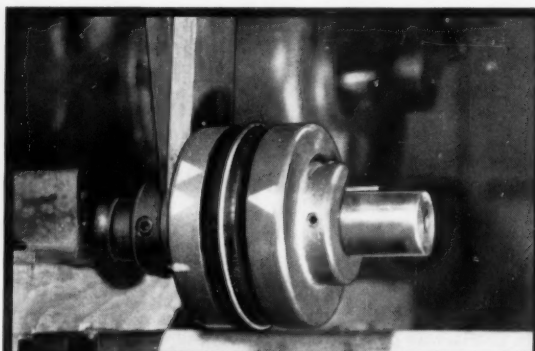
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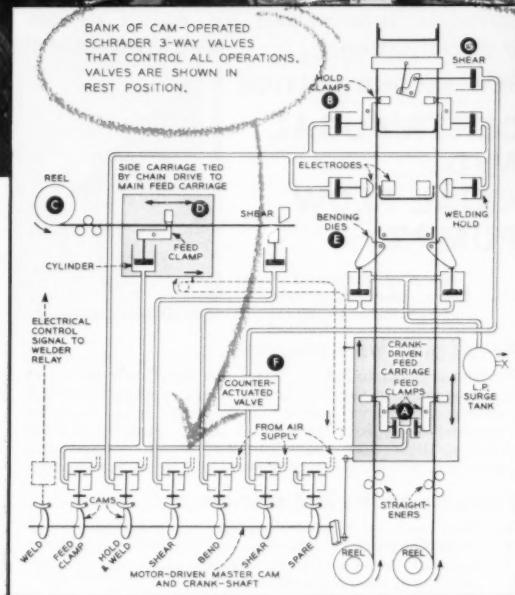
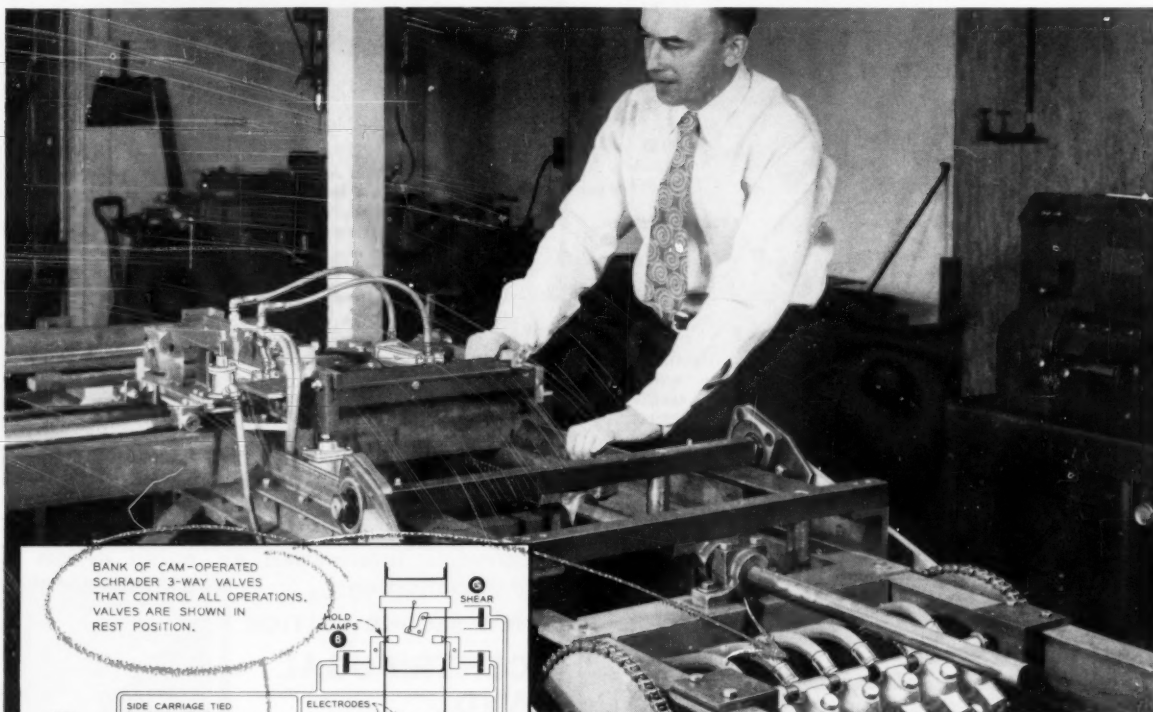
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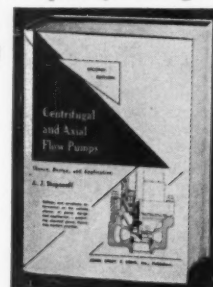
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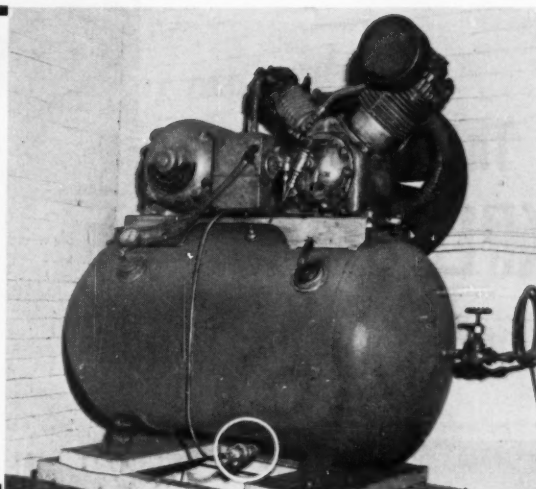
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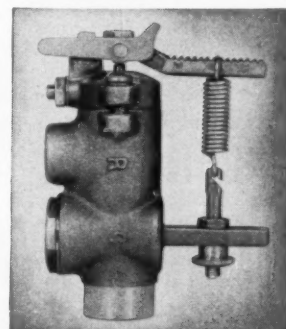
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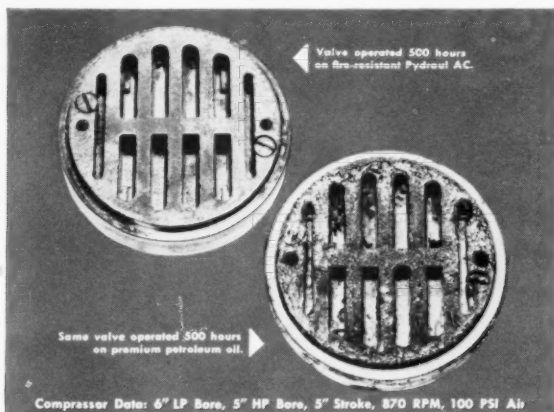
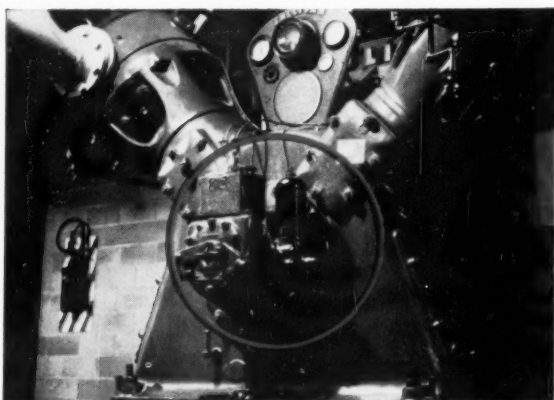
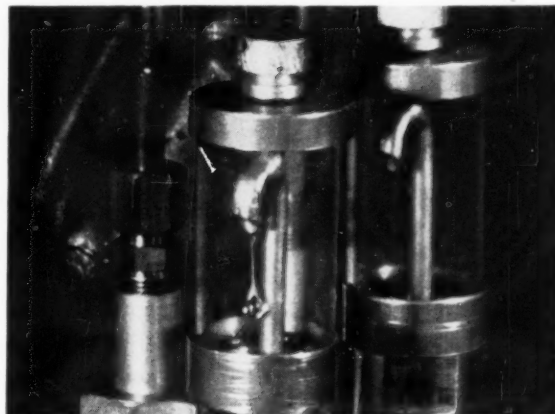


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